# OMEGA-Affirmative

## 1AC

## Plan

#### The United States federal government should substantially increase its financial incentives for algae-based biofuels produced in offshore membrane enclosures in the oceans.

## Solvency

#### Federal incentives for algae biofuels provide financial certainty – this speeds up R&D and enables a commercial demonstration

Kelsi Bracmort, 1/30/2014, Congressional Research Service, “Algae’s potential as a transportation biofuel,” <http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R42122.pdf>

Congress has debated whether algae-based biofuel could help diversify the U.S. transportation¶ fuel portfolio. While Congress has created a policy that mandates the use of alternative fuels for¶ transportation (e.g., RFS2) and set up tax credits that support alternative fuel production, much of¶ the legislation and tax provisions for alternative transportation fuel is constrained to a set of¶ feedstock types (e.g., cellulosic) and fuel types as defined in the statute (e.g., ethanol, biodiesel).¶ Going forward, Congress may choose to reevaluate how it supports alternative fuels by possibly¶ expanding the feedstock and fuel types that qualify for transportation and energy mandates. For¶ example, in the past the American Taxpayer Relief Act of 2012 (ATRA; P.L. 112-240) amended¶ both the cellulosic biofuel production tax credit and the cellulosic biofuel depreciation allowance¶ to include algae-based biofuels. Both tax incentives expired at the end of 2013 and it is not known¶ if the incentives will be extended. Additionally, algae is eligible for one part of the Biomass Crop¶ Assistance Program (BCAP).44¶ Some in Congress have expressed interest in ABB (algae-based biofuels) because it could have significantly lower¶ greenhouse gas emissions on a life-cycle basis than conventional fuels.45 If ABB (algae-based biofuels) is to become an¶ alternative to help reduce U.S. dependence on petroleum and reduce greenhouse gas emissions,¶ some stakeholders contend that consistent, comprehensive, long-term (for the duration of multiple¶ congressional sessions) policy support, as well as further research and development, would be¶ required. Options that have been proposed for policies to encourage ABB (algae-based biofuels) include modifying the¶ RFS2 (Renewable Fuel Standard), creating a federal low-carbon fuel standard, or placing a tax on carbon.¶ ABB advocates also assert that Congress could encourage the growth of the U.S. algae industry¶ by providing tax parity with other biofuels, appropriating additional federal funds for algae related¶ programs, and modifying the RFS2 (Renewable Fuel Standard) to be feedstock-neutral so that algae-based biofuels¶ can be more broadly included.46 Tax incentives may accelerate ABB research, development, and demonstration testing, thus possibly shortening the timeline for commercial ABB production.¶ However, some might argue that it is premature to issue tax breaks to an industry that has very¶ few commercial production facilities. Furthermore, it may be that tax breaks for renewable energy¶ in general will phase out under the emerging policy environment of fiscal discipline and budget¶ restraint. Opponents of such support argue that Congress should not be involved in selecting¶ biomass feedstock types for biofuels before commercial success has been proven, or more¶ broadly, that Congress should not be selecting the technology at any point. Congress did select¶ certain feedstock types for biofuel production under the RFS2. At the time, industry assertions¶ and government data supported the argument that certain levels of cellulosic biofuel production¶ capacity would be achievable within the given time frame, although these have not come to¶ pass.47¶ Given the federal budget situation, Congress could decide to expand the cellulosic biofuel¶ definition for the RFS to include algae and let industry take the research funding lead. This could¶ give the ABB (algae-based biofuel) industry a long-term goal and guaranteed market as part of the RFS (for roughly¶ 10 years). At a later time, perhaps after the ABB pilot projects that have come online yield data on¶ the feasibility of ABB production, Congress could have a legislative discussion about what¶ federal funding or other types of support, if any, would be appropriate.

#### OMEGA is a proven system for producing algae biofuels – but government backing is key to proving commercial viability

Jonathan Trent, 2012, (Trent studied at Scripps Institution of Oceanography, UC-SanDiego. He is the lead scientist on the OMEGA project), Slate Magazine, “grow your own energy,” <http://www.slate.com/articles/health_and_science/new_scientist/2012/09/algae_for_biofuel_omega_project_has_success_in_california_ready_to_scale_up_.html>

Before we run out of fossil oil, we will thoroughly tap the sea floor, find and frack wells wherever they may be, and excavate and extract the most recalcitrant of oil shales. In so doing, we will fuel our lifestyle for a few more decades at the cost of releasing vast amounts of carbon dioxide, adding to global warming, melting ice caps, raising sea levels, acidifying oceans—and setting course for a future for which there are few optimistic scenarios.¶ In the face of all this, scientists are racing to find alternatives. Biofuels are my passion, but they have had rather a bad press, from complaints about displacing food production to the inefficiency of soybeans and the carbon footprint of ethanol. Microalgae have a low profile but they deserve a much higher one, since the fossil oil we mine mostly comes from microalgae that lived in shallow seas millions of years ago—and they may be key to developing sustainable alternative fuels.¶ Algae are single-celled organisms that thrive globally in aqueous environments and convert CO2 into carbohydrates, protein, and natural oils. For some species, as much as 70 percent of their dry weight is made up of natural oils. Through transesterification (the process of adding three molecules of alcohol to one molecule of natural oil), the algae oils can be transformed into renewable fuels.¶ Microalgae hold great promise because some species are among the fastest growing plants alive and are therefore one of the best sources of biomass, while other species have been estimated to produce between 18,700 and 46,750 liters of oil per hectare per year, nearly a hundred times more than soybeans' 468 liters per hectare per year.¶ But there are big unsolved problems at which governments should be throwing funds and brainpower as if we were involved in a Manhattan project. For example, since few species of microalgae have been domesticated, we don't know how to grow them reproducibly or economically. At what scale will algae farming be efficient? To put this in perspective, U.S. planes use 80 billion liters of fuel per year. To supply this fuel from microalgae at the lower end of the estimated production rate would take 4.2 million hectares—twice the area of Wales.¶ Luckily, there may be a good way to cultivate this much algae while solving the ethical problem of producing biofuel without competing with agriculture. Freshwater algae can be grown in wastewater (effectively, water with fertilizer), or marine algae can be grown in a blend of seawater and wastewater. In both cases, wastewater provides a growth medium and the algae clean the wastewater by removing nutrients and pollutants from it. So there's no competition for fresh water needed elsewhere, no reliance on synthetic fertilizer, and the environment benefits.¶ The United Nations estimates that the world produces around 1,500 cubic kilometers of wastewater annually, of which more than 80 percent is untreated. This means there is an ample supply of nutrient-rich water for the algae, while algae treatment is available to offset the environmental impact of wastewater.¶ There remains the question of how and where to grow the algae. A few species are cultivated commercially on a small scale, in shallow channels called raceways or in enclosures called photobioreactors (PBRs). Raceways are relatively inexpensive, but need flat land, have lower yields than PBRs and problems with contamination and water loss from evaporation. PBRs have no problems with contamination or evaporation, but algae need light, and where there is light, there is heat: A sealed PBR will cook, rather than grow, algae. And mixing, circulating, and cleaning problems send costs sky high.¶ Assuming we can fix this, the question of siting remains. In order not to compete with agriculture, PBRs must use nonarable land reasonably close to a wastewater treatment plant. But in most cities, wastewater plants are surrounded by infrastructure, so installing PBRs on thousands of hectares around the plants would affect roads, buildings, and bridges—again driving up costs prohibitively.¶ A solution occurred to me: For coastal cities, we should try a system I call OMEGA: Offshore Membrane Enclosures for Growing Algae. Some 40 to 60 percent of Earth's population lives near a coast, most of the biggest cities are near a coast, and nearly all coastal cities discharge wastewater offshore.¶ How does OMEGA work? It uses PBRs [photobioreactors ] made from cheap, flexible plastic tubes floating offshore, and filled with wastewater, to grow freshwater, oil-producing algae. It would be easier to build the systems in protected bays, but breakwaters could also be constructed to control waves and strong currents. The water need not be deep or navigable, but a few things are crucial, including temperature, light, water clarity, frequency and severity of storms, boat traffic, nature and wildlife conservation.¶ Beyond solving the problem of proximity to wastewater plants, there are other advantages to being offshore. OMEGA uses buoyancy, which can be easily manipulated, to move the system up and down, influencing exposure to surface waves and adjusting light levels. And the overheating problem is eliminated by the heat capacity of the surrounding seawater.¶ The salt gradient between seawater and wastewater can also be exploited to drive forward osmosis. Using a semipermeable membrane, which allows water, but not salt, pollutants, or algae to pass through, wastewater is drawn into the saltwater with no added energy. In the process, algae are concentrated in preparation for harvesting and the wastewater is cleaned, first by the algae, and then by forward osmosis. This produces water clean enough to release into the marine environment or recover for reuse.¶ If OMEGA's freshwater algae are accidently released, they die in seawater, so no invasive species can escape into the ecosystem. In fact, OMEGA can improve conditions by providing a large surface for seaweed and invertebrates to colonize: part floating reef, part floating wetland. Then there are the extra possibilities of developing wind or wave power and aquaculture, growing food such as mussels.¶ OK, if it's so good, where is it? For the past two years, backed by NASA and the California Energy Commission, and about $11 million, we have crawled over every aspect of OMEGA. In Santa Cruz, Calif., we built and tested small-scale PBRs in seawater tanks. We studied OMEGA processing wastewater in San Francisco, and we investigated biofouling and the impact on marine life at the Moss Landing Marine Laboratories in Monterey Bay.¶ I'm now pretty confident we can deal with the biological, engineering, and environmental issues. So will it fly economically? Of the options we tested, the OMEGA system combined with renewable energy sources—wind, solar, and wave technologies—and aquaculture looks most promising. Now with funds running out and NASA keen to spin off OMEGA, we need the right half-hectare site for a scaled-up demonstration. While there is enthusiasm and great potential sites in places ranging from Saudi Arabia to New Zealand, Australia to Norway, Guantanamo Bay to South Korea, as yet no one has committed to the first ocean deployment.¶ We could be on the threshold of a crucial transition in human history—from hunting and gathering our energy to growing it sustainably. But that means getting serious about every option, from alpha to OMEGA.

#### Government support and funding can kick start algae biofuels

David Schwartz and Dr. Jonathan Trent, (interview), 8/26/2012, Earth Protect, “growing algae from wastewater runoff in the ocean,” <http://www.earthprotect.com/index.php/blogs/entry/99-growing-algae-from-wastewater-runoff-in-the-ocean>

[Q]: What do you think needs to happen, not just for the OMEGA project but for the future of this industry in general?¶ [A]: If you mean the algae industry as a way to make biofuels, my personal opinion is that the US should be investing the kind of money and brainpower that we invested in the Manhattan Project and Apollo. The Manhattan project was an investment of something like $22 billion (in 2008 dollars) over a five year period. And the whole Apollo program was about $98 billion over 14 years. They were amazing government-funded programs that mobilized the best and the brightest, actually from all over the world to reach socially and scientifically important goals.¶ Given the importance of liquid fuels, not only to the transportation industry, but to so many aspects of our society, and considering both the limited availability (peak oil and the location of reserves) and desirability (environmental impacts and national security) of fossil fuels, it’s highest time we make the transition away from fossil fuel dependence. The fossil fuel industry is nearly 150 years old and it represents some $5 trillion a year in revenue.¶ I think if we want to maintain a semblance of our lifestyle in the future, we need to seriously ask ourselves what it will take to replace the bulk of the fossil fuels we are currently using with sustainable, carbon neutral biofuels and can we do this in the next five to ten years? Then, we as a nation, should take on that enormous challenge with the determination of the Manhattan Project and the enthusiasm of the Apollo mission. With our current focus on the “economic crisis” I don’t know if the U.S. is up to this challenge. On the other hand, if we can invest over $1.2 trillion in the last ten years for wars in the middle east, perhaps we can find the resources to secure our own energy sources, energize a green economy, and make those wars obsolete.

#### The plan sets a global model for sustainable biofuels

Hsu 09

(NASA Uses Algae to Turn Sewage Into Fuel¶ by Jeremy Hsu, Journalist who covers science, technology and storytelling Special to SPACE.com | December 16, 2009 09:39am ET¶ 12¶ ¶ 23¶ ¶ 2¶ Submit¶ 0¶ Reddit¶ ¶ NASA Uses Algae to Turn Sewage Into Fuel¶ Pin It An illustration of an OMEGA ship harvesting algae to turn into fuel., http://www.space.com/7679-nasa-algae-turn-sewage-fuel.html, Date Accessed: 6.22.14)//BSpencer

**Still, the NASA bioengineer hopes that algae biofuels can eventually help satiate rising energy demands, and cut back on greenhouse gas emissions from burning fossil fuels that contribute to climate change.** The fact that **the OMEGA process would clean up wastewater and help sequester carbon dioxide doesn't hurt, either.¶** A U.S. company, Algae Systems of Carson City, Nev., has already licensed the NASA tech, and plans to deploy its own algae bioreactors somewhere off the coast of Tampa Bay, Florida. **Trent would like to see the technology spread among companies as an** open-source solution**.¶** "I **don't want to see any one company that owns the technology," Trent said. He has already begun discussing his work with international delegates at the United Nations Climate Change Conference hosted in Copenhagen, Denmark.¶ One possible future plan would combine the algae-growth system with a gigantic offshore wind farm being built by Germany, Sweden and Denmark**. Wind power could then provide lights to keep algae growing underwater and during the nighttime hours ? **a fitting vision for the sustainable future of spaceship Earth.**

#### Algae-based biofuels produced in the ocean can satisfy the fuel demands of the entire United States

Hsu 09

(NASA Uses Algae to Turn Sewage Into Fuel¶ by Jeremy Hsu, Journalist who covers science, technology and storytelling Special to SPACE.com | December 16, 2009 09:39am ET¶ 12¶ ¶ 23¶ ¶ 2¶ Submit¶ 0¶ Reddit¶ ¶ NASA Uses Algae to Turn Sewage Into Fuel¶ Pin It An illustration of an OMEGA ship harvesting algae to turn into fuel., http://www.space.com/7679-nasa-algae-turn-sewage-fuel.html, Date Accessed: 6.22.14)//BSpencer

**Many experts see algae as the biofuel source of the future for several reasons**. Algae's **biofuel yield could range from 1,000-4,000 gallons per acre each year**, compared to just hundreds of gallons per acre annually from oil palm, sunflower and soybeans, according to a U.S. Department of Energy (DOE) report. **The DOE added that algae alone could theoretically take care of transportation fuel demands for the entire United States.**¶ That early promise has led the **DOE to invest in algae-focused ventures through its new ARPA-E agency, and to put together a report titled the "National Algal Biofuels Technology Roadmap.**"¶ Some private companies have tried growing algae in vats or through other methods on land. But **Trent decided to take advantage of the ocean's natural waves and open spaces. His initial investigation drew support through a grant from the philanthropic arm of Google, the U.S. Internet search giant.**¶ **"This would ultimately cover acres and acres of ocean**," Trent told SPACE.com. He noted that each plastic bag might take up as much as a quarter of an acre. **The millions of acres required to meet U.S. transportation fuel needs would not take the form of one huge ocean patch, but would instead spread across many locations off the U.S. coasts**.¶ The basic **technologies behind the plastic bags and forward-osmosis membranes are well tested, but Trent expects to spend more time ensuring that the system can work efficiently and without problems**. For instance, plastics have a known weakness to ultraviolet rays from the sun, and so long exposure might represent an issue.¶ Still, **Trent wants to eventually make the plastic bags biodegradable. A future source of such biodegradable plastics might even come from algae-derived oil.**

## Advantage 1-Warming

#### Warming is anthropogenic – the science is on our side

Muller 2012 [Richard, professor of physics at the University of California, Berkeley, and a former MacArthur Foundation fellow, “The Conversion of a Climate-Change Skeptic”, http://www.nytimes.com/2012/07/30/opinion/the-conversion-of-a-climate-change-skeptic.html?pagewanted=all]

CALL me a converted skeptic. Three years ago I identified problems in previous climate studies that, in my mind, threw doubt on the very existence of global warming. Last year, following an intensive research effort involving a dozen scientists, I concluded that global warming was real and that the prior estimates of the rate of warming were correct. I’m now going a step further: Humans are almost entirely the cause. My total turnaround, in such a short time, is the result of careful and objective analysis by the Berkeley Earth Surface Temperature project, which I founded with my daughter Elizabeth. Our results show that the average temperature of the earth’s land has risen by two and a half degrees Fahrenheit over the past 250 years, including an increase of one and a half degrees over the most recent 50 years. Moreover, it appears likely that essentially all of this increase results from the human emission of greenhouse gases. These findings are stronger than those of the Intergovernmental Panel on Climate Change [IPCC], the United Nations group that defines the scientific and diplomatic consensus on global warming. In its 2007 report, the I.P.C.C. concluded only that most of the warming of the prior 50 years could be attributed to humans. It was possible, according to the I.P.C.C. consensus statement, that the warming before 1956 could be because of changes in solar activity, and that even a substantial part of the more recent warming could be natural. Our Berkeley Earth approach used sophisticated statistical methods developed largely by our lead scientist, Robert Rohde, which allowed us to determine earth land temperature much further back in time. We carefully studied issues raised by skeptics: biases from urban heating (we duplicated our results using rural data alone), from data selection (prior groups selected fewer than 20 percent of the available temperature stations; we used virtually 100 percent), from poor station quality (we separately analyzed good stations and poor ones) and from human intervention and data adjustment (our work is completely automated and hands-off). In our papers we demonstrate that none of these potentially troublesome effects unduly biased our conclusions. The historic temperature pattern we observed has abrupt dips that match the emissions of known explosive volcanic eruptions; the particulates from such events reflect sunlight, make for beautiful sunsets and cool the earth’s surface for a few years. There are small, rapid variations attributable to El Niño and other ocean currents such as the Gulf Stream; because of such oscillations, the “flattening” of the recent temperature rise that some people claim is not, in our view, statistically significant. What has caused the gradual but systematic rise of two and a half degrees? We tried fitting the shape to simple math functions (exponentials, polynomials), to solar activity and even to rising functions like world population. By far the best match was to the record of atmospheric carbon dioxide (CO2), measured from atmospheric samples and air trapped in polar ice.

#### 4 degree warming is inevitable with current carbon usage trends – only emissions reductions solve

Potsdam Institute, 2012 (Potsdam Institute for Climate Impact Research and Climate Analytics, “Turn Down the Heat: Why a 4°C Warmer World Must be Avoided”, A report for the World Bank, November, http://climatechange.worldbank.org/sites/default/files/Turn\_Down\_the\_heat\_Why\_a\_4\_degree\_centrigrade\_warmer\_world\_must\_be\_avoided.pdf)

The emission pledges made at the climate conventions in Copenhagen and Cancun, if fully met, place the world on a trajectory for a global mean warming of well over 3°C. Even if these pledges are fully implemented there is still about a 20 percent chance of exceeding 4°C in 2100.10 If these pledges are not met then there is a much higher likelihood—more than 40 percent—of warming exceeding 4°C by 2100, and a 10 percent possibility of this occurring already by the 2070s, assuming emissions follow the medium business-as-usual reference pathway. On a higher fossil fuel intensive business-as-usual pathway, such as the IPCC SRESA1FI, warming exceeds 4°C earlier in the 21st century. It is important to note, however, that such a level of warming can still be avoided. There are technically and economically feasible emission pathways that could still limit warming to 2°C or below in the 21st century. To illustrate a possible pathway to warming of 4°C or more, Figure 22 uses the highest SRES scenario, SRESA1FI, and compares it to other, lower scenarios. SRESA1FI is a fossil-fuel intensive, high economic growth scenario that would very likely cause mean the global temperature to exceed a 4°C increase above preindustrial temperatures. Most striking in Figure 22 is the large gap between the projections by 2100 of current emissions reduction pledges and the (lower) emissions scenarios needed to limit warming to 1.5–2°C above pre-industrial levels. This large range in the climate change implications of the emission scenarios by 2100 is important in its own right, but it also sets the stage for an even wider divergence in the changes that would follow over the subsequent centuries, given the long response times of the climate system, including the carbon cycle and climate system components that contribute to sea-level rise. The scenarios presented in Figure 22 indicate the likely onset time for warming of 4°C or more. It can be seen that most of the scenarios remain fairly close together for the next few decades of the 21st century. By the 2050s, however, there are substantial differences among the changes in temperature projected for the different scenarios. In the highest scenario shown here (SRES A1FI), the median estimate (50 percent chance) of warming reaches 4°C by the 2080s, with a smaller probability of 10 percent of exceeding this level by the 2060s. Others have reached similar conclusions (Betts et al. 2011). Thus, even if the policy pledges from climate convention in Copenhagen and Cancun are fully implemented, there is still a chance of exceeding 4°C in 2100. If the pledges are not met and present carbon intensity trends continue, then the higher emissions scenarios shown in Figure 22 become more likely, raising the probability of reaching 4°C global mean warming by the last quarter of this century. Figure 23 shows a probabilistic picture of the regional patterns of change in temperature and precipitation for the lowest and highest RCP scenarios for the AR4 generation of AOGCMS. Patterns are broadly consistent between high and low scenarios. The high latitudes tend to warm substantially more than the global mean. RCP8.5, the highest of the new IPCC AR5 RCP scenarios, can be used to explore the regional implications of a 4°C or warmer world. For this report, results for RCP8.5 (Moss et al. 2010) from the new IPCC AR5 CMIP5 (Coupled Model Intercomparison Project; Taylor, Stouffer, & Meehl 2012) climate projections have been analyzed. Figure 24 shows the full range of increase of global mean temperature over the 21st century, relative to the 1980–2000 period from 24 models driven by the RCP8.5 scenario, with those eight models highlighted that produce a mean warming of 4–5°C above preindustrial temperatures averaged over the period 2080–2100. In terms of regional changes, the models agree that the most pronounced warming (between 4°C and 10°C) is likely to occur over land. During the boreal winter, a strong “arctic amplification” effect is projected, resulting in temperature anomalies of over 10°C in the Arctic region. The subtropical region consisting of the Mediterranean, northern Africa and the Middle East and the contiguous United States is likely to see a monthly summer temperature rise of more than 6°C.

#### Not too late – every reduction key

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[Dana, is an environmental scientist at a private environmental consulting firm in the Sacramento, California area. He has a Bachelor's Degree in astrophysics from the University of California at Berkeley, and a Master's Degree in physics from the University of California at Davis. He has been researching climate science, economics, and solutions as a hobby since 2006, and has contributed to Skeptical Science since September, 2010, <http://www.skepticalscience.com/realistically-what-might-future-climate-look-like.html>, HM]

We're not yet committed to surpassing 2°C global warming, but as Watson noted, we are quickly running out of time to realistically give ourselves a chance to stay below that 'danger limit'. However, 2°C is not a do-or-die threshold. Every bit of CO2 emissions we can reduce means that much avoided future warming, which means that much avoided climate change impacts. As Lonnie Thompson noted, the more global warming we manage to mitigate, the less adaption and suffering we will be forced to cope with in the future. Realistically, based on the current political climate (which we will explore in another post next week), limiting global warming to 2°C is probably the best we can do. However, there is a big difference between 2°C and 3°C, between 3°C and 4°C, and anything greater than 4°C can probably accurately be described as catastrophic, since various tipping points are expected to be triggered at this level. Right now, we are on track for the catastrophic consequences (widespread coral mortality, mass extinctions, hundreds of millions of people adversely impacted by droughts, floods, heat waves, etc.). But we're not stuck on that track just yet, and we need to move ourselves as far off of it as possible by reducing our greenhouse gas emissions as soon and as much as possible. There are of course many people who believe that the planet will not warm as much, or that the impacts of the associated climate change will be as bad as the body of scientific evidence suggests. That is certainly a possiblity, and we very much hope that their optimistic view is correct. However, what we have presented here is the best summary of scientific evidence available, and it paints a very bleak picture if we fail to rapidly reduce our greenhouse gas emissions. If we continue forward on our current path, catastrophe is not just a possible outcome, it is the most probable outcome. And an intelligent risk management approach would involve taking steps to prevent a catastrophic scenario if it were a mere possibility, let alone the most probable outcome. This is especially true since the most important component of the solution - carbon pricing - can be implemented at a relatively low cost, and a far lower cost than trying to adapt to the climate change consequences we have discussed here (Figure 4).

#### 4 degrees of warming destroys global biodiversity – overwhelms resilience and adaptation – the impact is extinction

Potsdam Institute, 2012 (Potsdam Institute for Climate Impact Research and Climate Analytics, “Turn Down the Heat: Why a 4°C Warmer World Must be Avoided”, A report for the World Bank, November, http://climatechange.worldbank.org/sites/default/files/Turn\_Down\_the\_heat\_Why\_a\_4\_degree\_centrigrade\_warmer\_world\_must\_be\_avoided.pdf)

Ecosystems and their species provide a range of important goods and services for human society. These include water, food, cultural and other values. In the AR4 an assessment of climate change effects on ecosystems and their services found the following: • If greenhouse gas emissions and other stresses continue at or above current rates, the resilience of many ecosystems is likely to be exceeded by an unprecedented combination of change in climate, associated disturbances (for example, flooding, drought, wildfire, insects, and ocean acidification) and other stressors (global change drivers) including land use change, pollution and over-exploitation of resources. • Approximately 20 to 30 percent of plant and animal species assessed so far are likely to be at increased risk of extinction, if increases in global average temperature exceed of 2–3° above preindustrial levels. • For increases in global average temperature exceeding 2 to 3° above preindustrial levels and in concomitant atmospheric CO2 concentrations, major changes are projected in ecosystem structure and function, species’ ecological interactions and shifts in species’ geographical ranges, with predominantly negative consequences for biodiversity and ecosystem goods and services, such as water and food supply. It is known that past large-scale losses of global ecosystems and species extinctions have been associated with rapid climate change combined with other ecological stressors. Loss and/or degradation of ecosystems, and rates of extinction because of human pressures over the last century or more, which have intensified in recent decades, have contributed to a very high rate of extinction by geological standards. It is well established that loss or degradation of ecosystem services occurs as a consequence of species extinctions, declining species abundance, or widespread shifts in species and biome distributions (Leadley et al. 2010). Climate change is projected to exacerbate the situation. This section outlines the likely consequences for some key ecosystems and for biodiversity. The literature tends to confirm the conclusions from the AR4 outlined above. Despite the existence of detailed and highly informative case studies, upon which this section will draw, it is also important to recall that there remain many uncertainties (Bellard, Bertelsmeier, Leadley, Thuiller, and Courchamp, 2012). However, threshold behavior is known to occur in biological systems (Barnosky et al. 2012) and most model projections agree on major adverse consequences for biodiversity in a 4°C world (Bellard et al., 2012). With high levels of warming, coalescing human induced stresses on ecosystems have the potential to trigger large-scale ecosystem collapse (Barnosky et al. 2012). Furthermore, while uncertainty remains in the projections, there is a risk not only of major loss of valuable ecosystem services, particularly to the poor and the most vulnerable who depend on them, but also of feedbacks being initiated that would result in ever higher CO2 emissions and thus rates of global warming. Significant effects of climate change are already expected for warming well below 4°C. In a scenario of 2.5°C warming, severe ecosystem change, based on absolute and relative changes in carbon and water fluxes and stores, cannot be ruled out on any continent (Heyder, Schaphoff, Gerten, & Lucht, 2011). If warming is limited to less than 2°C, with constant or slightly declining precipitation, small biome shifts are projected, and then only in temperate and tropical regions. Considerable change is projected for cold and tropical climates already at 3°C of warming. At greater than 4°C of warming, biomes in temperate zones will also be substantially affected. These changes would impact not only the human and animal communities that directly rely on the ecosystems, but would also exact a cost (economic and otherwise) on society as a whole, ranging from extensive loss of biodiversity and diminished land cover, through to loss of ecosystems services such as fisheries and forestry (de Groot et al., 2012; Farley et al., 2012). Ecosystems have been found to be particularly sensitive to geographical patterns of climate change (Gonzalez, Neilson, Lenihan, and Drapek, 2010). Moreover, ecosystems are affected not only by local changes in the mean temperature and precipitation, along with changes in the variability of these quantities and changes by the occurrence of extreme events. These climatic variables are thus decisive factors in determining plant structure and ecosystem composition (Reu et al., 2011). Increasing vulnerability to heat and drought stress will likely lead to increased mortality and species extinction. For example, temperature extremes have already been held responsible for mortality in Australian flying-fox species (Welbergen, Klose, Markus, and Eby 2008), and interactions between phenological changes driven by gradual climate changes and extreme events can lead to reduced fecundity (Campbell et al. 2009; Inouye, 2008). Climate change also has the potential to facilitate the spread and establishment of invasive species (pests and weeds) (Hellmann, Byers, Bierwagen, & Dukes, 2008; Rahel & Olden, 2008) with often detrimental implications for ecosystem services and biodiversity. Human land-use changes are expected to further exacerbate climate change driven ecosystem changes, particularly in the tropics, where rising temperatures and reduced precipitation are expected to have major impacts (Campbell et al., 2009; Lee & Jetz, 2008). Ecosystems will be affected by the increased occurrence of extremes such as forest loss resulting from droughts and wildfire exacerbated by land use and agricultural expansion (Fischlin et al., 2007). Climate change also has the potential to catalyze rapid shifts in ecosystems such as sudden forest loss or regional loss of agricultural productivity resulting from desertification (Barnosky et al., 2012). The predicted increase in extreme climate events would also drive dramatic ecosystem changes (Thibault and Brown 2008; Wernberg, Smale, and Thomsen 2012). One such extreme event that is expected to have immediate impacts on ecosystems is the increased rate of wildfire occurrence. Climate change induced shifts in the fire regime are therefore in turn powerful drivers of biome shifts, potentially resulting in considerable changes in carbon fluxes over large areas (Heyder et al., 2011; Lavorel et al., 2006) It is anticipated that global warming will lead to global biome shifts (Barnosky et al. 2012). Based on 20th century observations and 21st century projections, poleward latitudinal biome shifts of up to 400 km are possible in a 4° C world (Gonzalez et al., 2010). In the case of mountaintop ecosystems, for example, such a shift is not necessarily possible, putting them at particular risk of extinction (La Sorte and Jetz, 2010). Species that dwell at the upper edge of continents or on islands would face a similar impediment to adaptation, since migration into adjacent ecosystems is not possible (Campbell, et al. 2009; Hof, Levinsky, Araújo, and Rahbek 2011). The consequences of such geographical shifts, driven by climatic changes as well as rising CO2 concentrations, would be found in both reduced species richness and species turnover (for example, Phillips et al., 2008; White and Beissinger 2008). A study by (Midgley and Thuiller, 2011) found that, of 5,197 African plant species studied, 25–42 percent could lose all suitable range by 2085. It should be emphasized that competition for space with human agriculture over the coming century is likely to prevent vegetation expansion in most cases (Zelazowski et al., 2011) Species composition changes can lead to structural changes of the entire ecosystem, such as the increase in lianas in tropical and temperate forests (Phillips et al., 2008), and the encroachment of woody plants in temperate grasslands (Bloor et al., 2008, Ratajczak et al., 2012), putting grass-eating herbivores at risk of extinction because of a lack of food available—this is just one example of the sensitive intricacies of ecosystem responses to external perturbations. There is also an increased risk of extinction for herbivores in regions of drought-induced tree dieback, owing to their inability to digest the newly resident C4 grasses (Morgan et al., 2008). The following provides some examples of ecosystems that have been identified as particularly vulnerable to climate change. The discussion is restricted to ecosystems themselves, rather than the important and often extensive impacts on ecosystems services. Boreal-temperate ecosystems are particularly vulnerable to climate change, although there are large differences in projections, depending on the future climate model and emission pathway studied. Nevertheless there is a clear risk of large-scale forest dieback in the boreal-temperate system because of heat and drought (Heyder et al., 2011). Heat and drought related die-back has already been observed in substantial areas of North American boreal forests (Allen et al., 2010), characteristic of vulnerability to heat and drought stress leading to increased mortality at the trailing edge of boreal forests. The vulnerability of transition zones between boreal and temperate forests, as well as between boreal forests and polar/tundra biomes, is corroborated by studies of changes in plant functional richness with climate change (Reu et al., 2011), as well as analyses using multiple dynamic global vegetation models (Gonzalez et al., 2010). Subtle changes within forest types also pose a great risk to biodiversity as different plant types gain dominance (Scholze et al., 2006). Humid tropical forests also show increasing risk of major climate induced losses. At 4°C warming above pre-industrial levels, the land extent of humid tropical forest, characterized by tree species diversity and biomass density, is expected to contract to approximately 25 percent of its original size [see Figure 3 in (Zelazowski et al., 2011)], while at 2°C warming, more than 75 percent of the original land can likely be preserved. For these ecosystems, water availability is the dominant determinant of climate suitability (Zelazowski et al., 2011). In general, Asia is substantially less at risk of forest loss than the tropical Americas. However, even at 2°C, the forest in the Indochina peninsula will be at risk of die-back. At 4°C, the area of concern grows to include central Sumatra, Sulawesi, India and the Philippines, where up to 30 percent of the total humid tropical forest niche could be threatened by forest retreat (Zelazowski et al., 2011). There has been substantial scientific debate over the risk of a rapid and abrupt change to a much drier savanna or grassland ecosystem under global warming. This risk has been identified as a possible planetary tipping point at around a warming of 3.5–4.5°C, which, if crossed, would result in a major loss of biodiversity, ecosystem services and the loss of a major terrestrial carbon sink, increasing atmospheric CO2 concentrations (Lenton et al., 2008)(Cox, et al., 2004) (Kriegler, Hall, Held, Dawson, and Schellnhuber, 2009). Substantial uncertainty remains around the likelihood, timing and onset of such risk due to a range of factors including uncertainty in precipitation changes, effects of CO2 concentration increase on water use efficiency and the CO2 fertilization effect, land-use feedbacks and interactions with fire frequency and intensity, and effects of higher temperature on tropical tree species and on important ecosystem services such as pollinators. While climate model projections for the Amazon, and in particular precipitation, remain quite uncertain recent analyses using IPCC AR4 generation climate indicates a reduced risk of a major basin wide loss of precipitation compared to some earlier work. If drying occurs then the likelihood of an abrupt shift to a drier, less biodiverse ecosystem would increase. Current projections indicate that fire occurrence in the Amazon could double by 2050, based on the A2 SRES scenario that involves warming of approximately 1.5°C above pre-industrial levels (Silvestrini et al., 2011), and can therefore be expected to be even higher in a 4°C world. Interactions of climate change, land use and agricultural expansion increase the incidence of fire (Aragão et al., 2008), which plays a major role in the (re)structuring of vegetation (Gonzalez et al., 2010; Scholze et al., 2006). A decrease in precipitation over the Amazon forests may therefore result in forest retreat or transition into a low biomass forest (Malhi et al., 2009). Moderating this risk is a possible increase in ecosystem water use efficiency with increasing CO2 concentrations is accounted for, more than 90 percent of the original humid tropical forest niche in Amazonia is likely to be preserved in the 2°C case, compared to just under half in the 4°C warming case (see Figure 5 in Zelazowski et al., 2011) (Cook, Zeng, and Yoon, 2012; Salazar & Nobre, 2010). Recent work has analyzed a number of these factors and their uncertainties and finds that the risk of major loss of forest due to climate is more likely to be regional than Amazon basin-wide, with the eastern and southeastern Amazon being most at risk (Zelazowski et al., 2011). Salazar and Nobre (2010) estimates a transition from tropical forests to seasonal forest or savanna in the eastern Amazon could occur at warming at warming of 2.5–3.5°C when CO2 fertilization is not considered and 4.5–5.5°C when it is considered. It is important to note, as Salazar and Nobre (2010) point out, that the effects of deforestation and increased fire risk interact with the climate change and are likely to accelerate a transition from tropical forests to drier ecosystems. Increased CO2 concentration may also lead to increased plant water efficiency (Ainsworth and Long, 2005), lowering the risk of plant die-back, and resulting in vegetation expansion in many regions, such as the Congo basin, West Africa and Madagascar (Zelazowski et al., 2011), in addition to some dry-land ecosystems (Heyder et al., 2011). The impact of CO2 induced ‘greening’ would, however, negatively affect biodiversity in many ecosystems. In particular encroachment of woody plants into grasslands and savannahs in North American grassland and savanna communities could lead to a decline of up to 45 percent in species richness ((Ratajczak and Nippert, 2012) and loss of specialist savanna plant species in southern Africa (Parr, Gray, and Bond, 2012). Mangroves are an important ecosystem and are particularly vulnerable to the multiple impacts of climate change, such as: rise in sea levels, increases in atmospheric CO2 concentration, air and water temperature, and changes in precipitation patterns. Sea-level rise can cause a loss of mangroves by cutting off the flow of fresh water and nutrients and drowning the roots (Dasgupta, Laplante et al. 2010). By the end of the 21st century, global mangrove cover is projected to experience a significant decline because of heat stress and sea-level rise (Alongi, 2008; Beaumont et al., 2011). In fact, it has been estimated that under the A1B emissions scenario (3.5°C relative to pre-industrial levels) mangroves would need to geographically move on average about 1 km/year to remain in suitable climate zones (Loarie et al., 2009). The most vulnerable mangrove forests are those occupying low-relief islands such as small islands in the Pacific where sea-level rise is a dominant factor. Where rivers are lacking and/ or land is subsiding, vulnerability is also high. With mangrove losses resulting from deforestation presently at 1 to 2 percent per annum (Beaumont et al., 2011), climate change may not be the biggest immediate threat to the future of mangroves. However if conservation efforts are successful in the longer term climate change may become a determining issue (Beaumont et al., 2011). Coral reefs are acutely sensitive to changes in water temperatures, ocean pH and intensity and frequency of tropical cyclones. Mass coral bleaching is caused by ocean warming and ocean acidification, which results from absorption of CO2 (for example, Frieler et al., 2012a). Increased sea-surface temperatures and a reduction of available carbonates are also understood to be driving causes of decreased rates of calcification, a critical reef-building process (De’ath, Lough, and Fabricius, 2009). The effects of climate change on coral reefs are already apparent. The Great Barrier Reef, for example, has been estimated to have lost 50 percent of live coral cover since 1985, which is attributed in part to coral bleaching because of increasing water temperatures (De’ath et al., 2012). Under atmospheric CO2 concentrations that correspond to a warming of 4°C by 2100, reef erosion will likely exceed rates of calcification, leaving coral reefs as “crumbling frameworks with few calcareous corals” (Hoegh-Guldberg et al., 2007). In fact, frequency of bleaching events under global warming in even a 2°C world has been projected to exceed the ability of coral reefs to recover. The extinction of coral reefs would be catastrophic for entire coral reef ecosystems and the people who depend on them for food, income and shoreline. Reefs provide coastal protection against coastal floods and rising sea levels, nursery grounds and habitat for a variety of currently fished species, as well as an invaluable tourism asset. These valuable services to often subsistence-dependent coastal and island societies will most likely be lost well before a 4°C world is reached. The preceding discussion reviewed the implications of a 4°C world for just a few examples of important ecosystems. The section below examines the effects of climate on biological diversity Ecosystems are composed ultimately of the species and interactions between them and their physical environment. Biologically rich ecosystems are usually diverse and it is broadly agreed that there exists a strong link between this biological diversity and ecosystem productivity, stability and functioning (McGrady-Steed, Harris, and Morin, 1997; David Tilman, Wedin, and Knops, 1996)(Hector, 1999; D Tilman et al., 2001). Loss of species within ecosystems will hence have profound negative effects on the functioning and stability of ecosystems and on the ability of ecosystems to provide goods and services to human societies. It is the overall diversity of species that ultimately characterizes the biodiversity and evolutionary legacy of life on Earth. As was noted at the outset of this discussion, species extinction rates are now at very high levels compared to the geological record. Loss of those species presently classified as ‘critically endangered’ would lead to mass extinction on a scale that has happened only five times before in the last 540 million years. The loss of those species classified as ‘endangered’ and ‘vulnerable’ would confirm this loss as the sixth mass extinction episode (Barnosky 2011). Loss of biodiversity will challenge those reliant on ecosystems services. Fisheries (Dale, Tharp, Lannom, and Hodges, 2010), and agronomy (Howden et al., 2007) and forestry industries (Stram & Evans, 2009), among others, will need to match species choices to the changing climate conditions, while devising new strategies to tackle invasive pests (Bellard, Bertelsmeier, Leadley, Thuiller, and Courchamp, 2012). These challenges would have to be met in the face of increasing competition between natural and agricultural ecosystems over water resources. Over the 21st-century climate change is likely to result in some bio-climates disappearing, notably in the mountainous tropics and in the poleward regions of continents, with new, or novel, climates developing in the tropics and subtropics (Williams, Jackson, and Kutzbach, 2007). In this study novel climates are those where 21st century projected climates do not overlap with their 20th century analogues, and disappearing climates are those 20th century climates that do not overlap with 21st century projected climates. The projections of Williams et al (2007) indicate that in a 4°C world (SRES A2), 12–39 percent of the Earth’s land surface may experience a novel climate compared to 20th century analogues. Predictions of species response to novel climates are difficult because researchers have no current analogue to rely upon. However, at least such climates would give rise to disruptions, with many current species associations being broken up or disappearing entirely. Under the same scenario an estimated 10–48 percent of the Earth’s surface including highly biodiverse regions such as the Himalayas, Mesoamerica, eastern and southern Africa, the Philippines and the region around Indonesia known as Wallacaea would lose their climate space. With limitations on how fast species can disperse, or move, this indicates that many species may find themselves without a suitable climate space and thus face a high risk of extinction. Globally, as in other studies, there is a strong association apparent in these projections between regions where the climate disappears and biodiversity hotspots. Limiting warming to lower levels in this study showed substantially reduced effects, with the magnitude of novel and disappearing climates scaling linearly with global mean warming. More recent work by Beaumont and colleagues using a different approach confirms the scale of this risk (Beaumont et al., 2011, Figure 36). Analysis of the exposure of 185 eco-regions of exceptional biodiversity (a subset of the so-called Global 200) to extreme monthly temperature and precipitation conditions in the 21st century compared to 1961–1990 conditions shows that within 60 years almost all of the regions that are already exposed to substantial environmental and social pressure, will experience extreme temperature conditions based on the A2 emission scenario (4.1°C global mean temperature rise by 2100) (Beaumont et al., 2011). Tropical and sub-tropical eco-regions in Africa and South America are particularly vulnerable. Vulnerability to such extremes is particularly acute for high latitude and small island biota, which are very limited in their ability to respond to range shifts, and to those biota, such as flooded grassland, mangroves and desert biomes, that would require large geographical displacements to find comparable climates in a warmer world. The overall sense of recent literature confirms the findings of the AR4 summarized at the beginning of the section, with a number of risks such as those to coral reefs occurring at significantly lower temperatures than estimated in that report. Although non-climate related human pressures are likely to remain a major and defining driver of loss of ecosystems and biodiversity in the coming decades, it is also clear that as warming rises so will the predominance of climate change as a determinant of ecosystem and biodiversity survival. While the factors of human stresses on ecosystems are manifold, in a 4°C world, climate change is likely to become a determining driver of ecosystem shifts and large-scale biodiversity loss (Bellard et al., 2012; New et al., 2011). Recent research suggests that large-scale loss of biodiversity is likely to occur in a 4°C world, with climate change and high CO2 concentration driving a transition of the Earth´s ecosystems into a state unknown in human experience. Such damages to ecosystems would be expected to dramatically reduce the provision of ecosystem services on which society depends (e.g., hydrology—quantity flow rates, quality; fisheries (corals), protection of coastline (loss of mangroves). Barnosky has described the present situation facing the biodiversity of the planet as “the perfect storm” with multiple high intensity ecological stresses because of habitat modification and degradation, pollution and other factors, unusually rapid climate change and unusually high and elevated atmospheric CO2 concentrations. In the past, as noted above, this combination of circumstances has led to major, mass extinctions with planetary consequences. Thus, there is a growing risk that climate change, combined with other human activities, will cause the irreversible transition of the Earth´s ecosystems into a state unknown in human experience (Barnosky et al., 2012).

**Algae biofuels solve warming – they are carbon neutral and can meet the fuel needs of the entire transportation sector**

AFP 08

AFP July 10 2008 “As planet swelters, are algae unlikely saviour?”, <http://afp.google.com/article/ALeqM5ir4Mg2eQ23RPDhBkH2BnulZai-ZA>

As the world mulls over the conundrum of how to satisfy a seemingly endless appetite for energy and still slash greenhouse gas emissions, **researchers have stumbled upon an unexpected hero: algae.** So-called microalgae **hold enormous potential when it comes to reining in both climate change,** since they naturally absorb large amounts of carbon dioxide, **as well as energy production,** since they can easily be converted to a range of different fuel types. "**This is** certainly one of **the most promising and revolutionary leads in the fight against climate change and the quest to satisfy energy needs**," Frederic Hauge, who heads up the Norwegian environmental group Bellona, told AFP. The idea is to divert exhaust spewed from carbon burning plants and other factories into so-called "photobioreactors", or large transparent tubes filled with algae. **When the gas is mixed with water and injected into the tubes, the algae soak up much of the carbon dioxide, or CO2, in accordance with the principle of photosynthesis.** The pioneering technique, called solar biofuels, is one of a panoply of novel methods aiming to crack the problem of providing energy but without the carbon pollution of costly fossil fuels -- with oil pushing 140 dollars a barrel and supplies dwindling -- or the waste and danger of nuclear power. Studies are underway worldwide, from academia in Australia, Germany and the US, to the US Department of Energy, oil giant Royal Dutch Shell and US aircraft maker Boeing. This week alone, Japanese auto parts maker Denso Corp., a key supplier to the Toyota group, said it too would start investigating, to see if algae could absorb CO2 from its factories. The prestigious Massachusetts Institute of Technology (MIT), for one, has successfully tested the system, finding that once filtered through the algae broth, fumes from a cogeneration plant came out 50-85 percent lighter on CO2 and contained 85 percent less of another potent greenhouse gas, nitrogen oxide. Once the microalgae are removed from the tubes they can easily be buried or injected into the seabed, and thus hold captive the climate changing gases they ingest indefinitely. **And when algae grown out in the open are used in biomass plants, the method can actually produce "carbon negative" energy, meaning the energy production actually drains CO2 from the atmosphere.** This is possible since the microalgae first absorbs CO2 as it grows and, although the gas is released again when the biomass burns, the capturing system keeps it from re-entering the air. "Whether you are watching TV, vacuuming the house, or driving your electric car to visit friends and family, you would be removing CO2 from the atmosphere," Hauge said. Instead of being stored away, the algae can also be crushed and used as feedstock for biodiesel fuel -- something that could help the airline industry among others to improve its environmental credentials. In fact, even the algae residue remaining after the plants are pressed into biodiesel could be put to good use as mineral-rich fertiliser, Hauge said "You kill three birds with one stone. The algae serves at once to filter out CO2 at industrial sites, to produce energy and for agriculture," he pointed out. Compared with the increasingly controversial first-generation biofuels made from food crops like sunflowers, rapeseed, wheat and corn, microalgae have the huge advantage of not encroaching on agricultural land or affecting farm prices, and can be grown whenever there's sunlight. They also can yield far more oil than other oleaginous plants grown on land. "To cover US fuel needs with biodiesel extracted from the most efficient terrestrial plant, palm oil, it would be necessary to use 48 percent of the country's farmland," according to a recent study by the Oslo-based Centre for International Climate and Environmental Research. **"The United States could potentially replace all of its petrol-based automobile fuel by farming microalgae** on a surface corresponding to five percent of the country's farmland," the study added**.**

#### Algae farms sequester C02 – that slows warming

Fulke et al May 21 2014

CO2 Sequestration by Microalgae: Advances and Perspectives¶ [Abhay Fulke](http://www.researchgate.net/researcher/37859486_Abhay_Fulke), [T Chakrabarti](http://www.researchgate.net/researcher/38971680_T_Chakrabarti), [K Krishnamurthi](http://www.researchgate.net/researcher/38356818_K_Krishnamurthi), [S Saravana Devi](http://www.researchgate.net/researcher/39817821_S_Saravana_Devi)¶ Recent Advances in Microalgal Biotechnology, Chapter: CO2 Sequestration by Microalgae: Advances and Perspectives, Publisher: OMICS Group Incorporation, 731 Gull Ave,Foster City. CA 94404, USA, Editors: Dr. Jin Liu, Dr. Zheng Sun and Dr. Henri Gerken, May 21 2014 pp.1-7 http://www.researchgate.net/publication/260612787\_CO2\_Sequestration\_by\_Microalgae\_Advances\_and\_Perspectives

Carbon dioxide, a Greenhouse Gas (GHG), is the one of the principle pollutant, warming the earth. In the past 150 years, anthropogenic activities have pumped enough carbon dioxide into the atmosphere to raise its levels to 400 ppm, higher than they have been for hundreds of thousands of years. In the global effort to combat the climate change, several CO2 capture and storage technologies are deliberated. Because of photosynthetic ability of microalgae, the potential microalgae such as Chlorella vulgaris, Scenedesmus sp., Chroococcus sp. and Chlamydomonas sp. have been actively used globally in closed and open photobioreactors for CO2 mitigation. Algae as feed stocks for bio-energy refer to a diverse group of organisms that include microalgae, macroalgae (seaweed) and cyanobacteria (formerly called “blue-green algae”). Algae occur in a variety of natural aqueous and terrestrial habitats in environment. Under certain conditions, some microalgae have the potential to accumulate lipids. Algal biofuel generation imbibes both carbon sequestration and energy production. Further, special emphasis is required on regulation of biosynthetic genes and its expression in microalgae under various CO2 stress conditions for sequestration.

## Advantage 2: Food Security

#### Domestic corn-ethanol production is the root of massive species loss and ecosystem destruction in the Great Plains

Specht 13

[Jonathan-J.D. Wash. U St. Louis, Legal Advisor, “Raising Cane: Cuban Sugarcane Ethanol’s Economic and Environmental Effects on the United States,” Environmental Law & Policy Journal, Univ. of California Davis, Vol. 36:2, <http://environs.law.ucdavis.edu/issues/36/2/specht.pdf>]

Incentivizing farmers to grow consecutive corn crops instead of alternating with soybean crops is only the least damaging of the environmentally detrimental land use changes that the domestic ethanol industry encourages. Land is primarily converted to corn production in one of three ways: land that is already used to grow another crop is converted to corn production, land that is used for pasture or is enrolled in a program like the Conservation Reserve Program n69 is converted to cropland, or native habitat is plowed and converted to [\*184] cropland. n70 Each of these has varying levels of negative environmental effects. All three types of land use conversions are underway in the Great Plains states, which have ramped up corn production in response to demand from the ethanol industry. n71 While it is not the only reason corn production is increasing in these states, n72 the corn-based ethanol industry and thus the governmental policies encouraging it are clearly factors driving land use conversion. "While many factors influence land-use changes, the relationship between ethanol incentives and habitat destruction is fairly clear. Ethanol incentives increase demand for corn, which in turn increases corn prices. Increased corn prices lead to land being converted from other uses to corn production." n73¶ Converting pasture or Conservation Reserve Program Land to cropland causes more damage than changing crop rotation patterns in already cropped land. n74 Yet, the most environmentally damaging way of converting land to crop production is to plow native habitat and plant it with row crops. n75 This process is underway now in the Great Plains, with devastating environmental effects. Although the most recent data is from 2007, the USDA's census of agriculture (published every five years) provides a clear picture of the trend lines of U.S. agricultural production. This picture is one of greatly increased corn production in the Great Plains states. According to the Census of Agriculture, the number of acres of corn production in North Dakota has increased from 592,078 acres in 1997 to 991,390 acres in 2002 n76 to 2,348,171 acres in 2007, n77 representing more [\*185] than a doubling over five years and close to a quadrupling over ten years. Similarly, in South Dakota, the number of acres in corn grew from 3,165,190 in 2002 to 4,455,368 in 2007, n78 an increase of forty-one percent over five years. In Nebraska, the number of acres in corn (for grain) increased from 7,344,715 in 2002 to 9,192,656 in 2007, n79 a more modest but still significant increase of twenty-five percent over five years.¶ While a major portion of this increase in corn production in the Great Plain states is attributable to farmers converting land already used to grow other crops or pasture to corn production, n80 much of it also derives from plowing native habitat. "Recent dramatic increases in corn plantings have been heavily concentrated in the Prairie Pothole Region, displacing other crops as well as sensitive prairie pothole habitat." n81 The trend of replacing native habitat with fields of corn is an extremely worrying development, and is arguably the strongest reason for displacing at least some domestic corn-based ethanol with Cuban sugarcane-based ethanol. Therefore, this trend will be discussed in some depth.¶ Increased corn production is degrading two environmentally significant habitats in the Great Plains, grasslands and wetlands. According to The Nature Conservancy, "grasslands and prairies are the world's most imperiled ecosystem." n82 While grasslands once stretched across the entire central portion of the United States, it has lost between eighty-three and ninety-nine percent of its original tall grass prairie habitat. n83 U.S. grasslands are the native habitat of a number of threatened and endangered species, such as the greater prairie [\*186] chicken, n84 which cannot live in cornfields. n85 In addition to reducing the overall amount of habitat available to native species, the process of plowing grassland to grow crops fragments habitat by splitting it into disconnected segments. n86 The negative effects on wildlife of converting grasslands to corn fields, and thereby also fragmenting what habitat remains, are well-documented. "In counties with high corn [production] increases, the average number of grassland [bird] species was found to decline significantly from 2005 to 2008." n87¶ Furthermore, in addition to providing habitat for wildlife, grasslands act as a carbon sink, keeping centuries' worth of accumulated atmospheric carbon in underground root systems. n88 When native grassland is plowed to grow crops like corn, the carbon stored in its soil is released into the atmosphere, further exacerbating climate change and counterbalancing the greenhouse gas benefits of replacing fossil fuel-based gasoline with corn-based ethanol. n89 Taken together, the environmental costs of increasing domestic corn-based ethanol production by plowing native grasslands in the Great Plains starkly outweigh their benefits. "Plowing up our nation's last remnants of native grasslands to grow more corn for ethanol is like burning the Mona Lisa for firewood." n90¶ Along with grasslands, wetlands are the other major habitat type in the Great Plains that are being damaged by the domestic corn-based ethanol industry. The draining of wetlands to convert them to agricultural production is a practice in American agriculture that predates the domestic ethanol industry. n91 This trend has been exacerbated by a number of legal and policy factors unrelated to ethanol production (including a 2001 Supreme Court decision interpreting the [\*187] Clean Water Act). n92 To the extent that it increases demand for corn and thus the price of corn, however, the domestic ethanol industry is clearly a factor driving the conversion of wetlands to corn production. This conversion process is a land use change with wide-ranging environmental consequences. The Prairie Pothole region of the Dakotas and surrounding states - which is composed of a mixture of grasslands and wetlands - is a habitat of international significance. n93 Nearly forty percent of all species of migratory birds in North America - over 300 species - utilize this habitat at some point in their life cycles or yearly migrations. n94 The region is where "millions of ducks and geese are born each year." n95 The two greatest threats to North American ducks are the destruction of wetlands and the degradation of prairies, both of which are being driven by the expansion of U.S. corn production. n96 In addition to providing habitat for wildlife, both grasslands and wetlands help to clean up pollution and prevent flooding. n97 "Those areas with native vegetation, and the soils beneath their surface, also retain the water longer throughout the season and use up the water through evapotranspiration." n98 Thus, converting grasslands and wetlands to cropland for corn increases the risk of flooding. n99¶ Taken together, the consequences of converting grasslands and wetlands in the Great Plains to increase corn production for the domestic ethanol industry are devastating.¶ If we proceed along the current trajectory without changing federal policies [including those promoting corn-based ethanol], the prairie pothole ecosystem may be further degraded and fragmented, and the many services it provides will be impossible to restore. The region will no longer be able to support the waterfowl cherished by hunters and wildlife enthusiasts across the country. Grassland bird populations, already declining, will be unable to rebound as [\*188] nesting sites are turned into row crops. Water will become increasingly polluted and costly to clean as the grasslands and wetlands that once filtered contaminants disappear. n100

#### Monoculture model independently causes extinction

Leahy 7

[Stephen- international environmental journalist, “Biodiversity: Farming Will Make or Break the Food Chain”, Inter Press Service, 5-3-07,http://www.commondreams.org/archive/2007/05/03/945/]

"If all agricultural lands adopt the industrial, monocultural model, there will be enormous impacts on water and other essential services provided by diverse ecosystems," Jackson told IPS.¶ Societies need to recognize the value of ecosystem services and encourage farmers to use methods that benefit biodiversity, she says.¶ Biodiversity refers to the amazing variety of living things that make up the biosphere, the thin skin of life that covers the Earth and is, as far as we know, unique in the universe. The trees, plants, insects, bacteria, birds and animals that make up forest ecosystems produce oxygen, clean water, prevent erosion and flooding, and capture excess carbon dioxide, among other things.¶ "There is an unbreakable link between human health and well being and ecosystems," Walter Reid, director of the Millennium Ecosystem Assessment (MA) and a professor with the Institute for the Environment at Stanford University, told IPS last year.¶ The MA is a 22-million-dollar, four-year global research initiative commissioned by the United Nations, and carried out by 1,360 experts from 95 countries. Its mission has been to examine ways to slow or reverse the degradation of the Earth's ecosystems, including a look at what the future may be like in 2050.¶ The more species and diversity there are in an ecosystem, the more robust it is. Remove some species and it will continue to function. However, like a complex house of cards, removing key cards or too many cards results in a collapse.¶ For many ecosystems such as oceans, scientists do not know what the key cards are or how many lost species is too many.

#### Algae-biofuels can displace corn ethanol

WWI 2013

(Better Than Corn? Algae Set to Beat Out Other Biofuel Feedstocks¶ Algae¶ One acre of algae can produce enough oil to make 5,000 gallons of biodiesel in a year. 2013 Worldwatch Institute http://www.worldwatch.org/node/5391, Date Accessed: 6.22.14)//BSpencer

**Forget corn, sugar cane, and even switch-grass**. Some **experts believe that algae is set** to eclipse all other biofuel feed-stocks **as the cheapest, easiest, and most environmentally friendly way to produce liquid fuel**, reports Kiplinger’s Biofuels Market Alert. “**It is easy to get excited about algae,” says Worldwatch Institute biofuels expert Raya Widenoja. “It looks like such a promising fuel source, especially if it’s combined with advances in biodiesel processing**.”¶ The inputs for algae are simple: the single-celled organisms only need sunlight, water, and carbon dioxide to grow. They **can quadruple in biomass in just one day, and they help remove carbon from the air and nitrogen from wastewater, another environmental benefit.** Some types of algae comprise more than 50 percent oil, and an average acre of algae grown today for pharmaceutical industries can produce 5,000 gallons (19,000 liters) of biodiesel each year. By comparison, an average acre of corn produces 420 gallons (1,600 liters) of ethanol per year, and an acre of soybeans yields just 70 gallons (265 liters) of biodiesel per year.¶ “Your bang for your buck is just bigger because you can really do this on a much smaller amount of land and yet yield much, much higher biomass,” said Michael S. Atkins, CEO of San Francisco area-based Ocean Technology & Environmental Consulting (OTEC). Douglas Henston, CEO of Solix Biofuels, a company that grows algae for biofuels, has estimated that replacing all current U.S. diesel fuel use with algae biodiesel would require using only about one half of 1 percent of the farmland in production today. Algae can also grow on marginal lands, such as in desert areas where the groundwater is saline**.**

#### Algae can corner the market – traditional ethanol won’t be able to compete

G.C.R., 4/20/2012, Green Car Reports, “NASA ready to show off algae biofuel research project,” <http://www.greencarreports.com/news/1075546_nasa-ready-to-show-off-algae-biofuel-research-project>

NASA has developed a system that captures carbon dioxide and helps to prevent pollution from wastewater while creating renewable algae biofuel, fertilizer and possibly animal feed, too.¶ NASA calls its system OMEGA, for Offshore Membrane Enclosures for Growing Algae, self-contained bags of wastewater and fast-growing algae cultures that are designed to float in seawater off the coast of a landmass and produce biofuels, NASA hopes for fueling planes.¶ As the algae grow inside the bags, they absorb sunlight and carbon dioxide through the bags’ membranes and produce oxygen, which releases to the atmosphere through the membrane.¶ The algae also absorb nutrients, creating fresh water that passes easily through the membrane into the sea, acting as a next-level treatment phase, helping to reduce the risk of creating local dead zones.¶ The OMEGA system has been undergoing test runs at the San Francisco Public Utilities Commission’s Southeast Water Pollution Control Plant. A demonstration scale operation is now ready for its close-up, including an April 17 media tour.¶ OMEGA was developed at NASA’s Ames Research Center in California.¶ NASA claims the OMEGA system is far more efficient than conventional algae farming methods.¶ By growing the algae within a bag rather than in open ponds or channels, OMEGA eliminates the need for water-circulating equipment and virtually eliminates water loss due to evaporation.¶ OMEGA also reduces or eliminates the need for energy-sucking climate control systems that would be needed to regulate the temperature of land-based water storage facilities.¶ Aside from producing oil, fresh water and oxygen, the spent algae can be reclaimed for use as a fertilizer or soil enhancer. Researchers are also beginning to test algae as a feed supplement for livestock.¶ Equipment maintenance and lifecycle expenses are another important consideration for cost-effective algae farming, and OMEGA wins out here, too. The system involves few moving parts and the plastic tubes could be recycled when their useful life is up.¶ Algae, especially freshwater algae, is an attractive biofuel due to its ability to grow rapidly while producing lipid cells bursting with oil.¶ Other biofuel crops just can’t compete: according to NASA, some algae can produce more than 2,000 gallons of oil per acre per year, compared to only 600 gallons for palm. Soy beans fare even worse, at only 50 gallons per acre per year.

#### Corn ethanol spikes global food prices – that leads to global instability

Brown ‘7 (Lester R. Brown,a United States environmental analyst, founder of the Worldwatch Institute, and founder and president of the Earth Policy Institute, on. Found at http://www.earthpolicy.org/plan\_b\_updates/2007/update65)

If you think you are spending more each week at the supermarket, you may be right. Theescalating share of the U.S. grain harvest going to ethanol distilleries is driving up food prices worldwide.¶ Corn prices have doubled over the last year, wheat futures are trading at their highest level in 10 years, and rice prices are rising too. In addition, soybean futures have risen by half. A Bloomberg analysis notes that the soaring use of corn as the feedstock for fuel ethanol “is creating unintended consequences throughout the global food chain.”¶ The countries initially hit by rising food prices are those where corn is the staple food. In Mexico, one of more than 20 countries with a corn-based diet, the price of tortillas is up by 60 percent. Angry Mexicans in crowds of up to 75,000 have taken to the streets in protest, forcing the government to institute price controls on tortillas. ¶ Food prices are also rising in China, India, and the United States, countries that contain 40 percent of the world’s people. While relatively little corn is eaten directly in these countries, vast quantities are consumed indirectly in meat, milk, and eggs in both China and the United States.¶ Rising grain and soybean prices are driving up meat and egg prices in China. January pork prices were up 20 percent above a year earlier, eggs were up 16 percent, while beef, which is less dependent on grain, was up 6 percent. ¶ In India, the overall food price index in January 2007 was 10 percent higher than a year earlier. The price of wheat, the staple food in northern India, has jumped 11 percent, moving above the world market price. ¶ In the United States, the U.S. Department of Agriculture projects that the wholesale price of chicken in 2007 will be 10 percent higher on average than in 2006, the price of a dozen eggs will be up a whopping 21 percent, and milk will be 14 percent higher. And this is only the beginning. ¶ In the past, food price rises have usually been weather related and always temporary. This situation is different. As more and more fuel ethanol distilleries are built, world grain prices are starting to move up toward their oil-equivalent value in what appears to be the beginning of a long-term rise.¶ The food and energy economies, historically separate, are now merging. In this new economy, if the fuel value of grain exceeds its food value, the market will move it into the energy economy. As the price of oil climbs so will the price of food.¶ Some 16 percent of the 2006 U.S. grain harvest was used to produce ethanol. With 80 or so ethanol distilleries now under construction, enough to more than double existing ethanol production capacity, nearly a third of the 2008 grain harvest will be going to ethanol. ¶ Since the United States is the leading exporter of grain, shipping more than Canada, Australia, and Argentina combined**,** what happens to the U.S. grain crop affects the entire world. With the massive diversion of grain to produce fuel for cars, exports will drop. The world’s breadbasket is fast becoming the U.S. fuel tank.¶ The number of hungry people in the world has been declining for several decades, but in the late 1990s the trend reversed and the number began to rise. The United Nations currently lists 34 countries as needing emergency food assistance. Many of these are considered failed and failing states, including Chad, Iraq, Liberia, Haiti, and Zimbabwe. Since food aid programs typically have fixed budgets, if the price of grain doubles, food aid will be reduced by half. ¶ Urban food protests in response to rising food prices in low and middle income countries, such as Mexico, couldlead to political instability that would add to the growing list of failed and failing states. At some point, spreading political instability could disrupt global economic progress.¶ Against this backdrop, Washington is consumed with “ethanol euphoria.” President Bush in his State of the Union address set a production goal for 2017 of 35 billion gallons of alternative fuels, including grain-based and cellulosic ethanol, and liquefied coal. Given the current difficulties in producing cellulosic ethanol at a competitive cost and given the mounting public opposition to liquefied coal, which is far more carbon-intensive than gasoline, most of the fuel to meet this goal might well have to come from grain. This could take most of the U.S. grain harvest, leaving little grain to meet U.S. needs, much less those of the hundred or so countries that import grain.¶ The stage is now set for direct competition for grain between the 800 million people who own automobiles, and the world’s 2 billion poorest people. The risk is that millions of those on the lower rungs of the global economic ladder will start falling off as higher food prices drop their consumption below the survival level.¶

#### Food insecurity is a conflict escalator--most probable scenario for nuclear war

Future Directions International ’12 (“International Conflict Triggers and Potential Conflict Points Resulting from Food and Water Insecurity Global Food and Water Crises Research Programme”, May 25, <http://www.futuredirections.org.au/files/Workshop_Report_-_Intl_Conflict_Triggers_-_May_25.pdf>, )

There is a growing appreciation that the conflicts in the next century will most likely be fought over a lack of resources. Yet, in a sense, this is not new. Researchers point to the French and Russian revolutions as conflicts induced by a lack of food. More recently, Germany’s World War Two efforts are said to have been inspired, at least in part, by its perceived need to gain access to more food. Yet the general sense among those that attended FDI’s recent workshops, was that the scale of the problem in the future could be significantly greater as a result of population pressures, changing weather, urbanisation, migration, loss of arable land and other farm inputs, and increased affluence in the developing world. In his book, Small Farmers Secure Food, Lindsay Falvey, a participant in FDI’s March 2012 workshop on the issue of food and conflict, clearly expresses the problem and why countries across the globe are starting to take note. . He writes (p.36), “…if people are hungry, especially in cities, the state is not stable – riots, violence, breakdown of law and order and migration result.” “Hunger feeds anarchy.” This view is also shared by Julian Cribb, who in his book, The Coming Famine, writes that if “large regions of the world run short of food, land or water in the decades that lie ahead, then wholesale, bloody wars are liable to follow.” He continues: “An increasingly credible scenario for World War 3 is not so much a confrontation of super powers and their allies, as a festering, self-perpetuating chain of resource conflicts.” He also says: “The wars of the 21st Century are less likely to be global conflicts with sharply defined sides and huge armies, than a scrappy mass of failed states, rebellions, civil strife, insurgencies, terrorism and genocides, sparked by bloody competition over dwindling resources.” As another workshop participant put it, people do not go to war to kill; they go to war over resources, either to protect or to gain the resources for themselves. Another observed that hunger results in passivity not conflict. Conflict is over resources, not because people are going hungry. A study by the International Peace Research Institute indicates that where food security is an issue, it is more likely to result in some form of conflict. Darfur, Rwanda, Eritrea and the Balkans experienced such wars. Governments, especially in developed countries, are increasingly aware of this phenomenon. The UK Ministry of Defence, the CIA, the US Center for Strategic and International Studies and the Oslo Peace Research Institute, all identify famine as a potential trigger for conflicts and possibly even nuclear war.

#### Food crisis causes destabilizes Russia, china, and india

Global Torchlight, (Global Torchlight, specialised consultancy advising on a full spectrum of international political and security issues, founding members include John C. Amble, former intelligence officer at the Defense Intelligence Agency, and David J. Chmiel, MA from the War Studies Department at King’s College London, "Drought, Rising Food Prices, and Political Instability," 8--20--12, http://globaltorchlight.com/?p=2289, accessed 11-6-12.

Adverse climatic conditions this year in regions such as the United States, the Black Sea, and India are combining to generate lower than average crop yields and put upward pressure on food prices that will last well into 2013. While those with international business interests will be attuned to the economic and financial consequences of such price increases, equal attention should be paid to their potential impact on the political and security risk environment in emerging and developing markets over the coming months. Such risks could take many forms, but three warrant particular mention. First, substantial and sustained rises in food prices are likely to place pressure on governments in many emerging markets to subsidise the prices of staple foods. As has been noted in previous analysis on globaltorchlight.com, such subsidies often do more harm than good to an economy in the long run. They distort market mechanisms and give rise to increased potential for fraud and corruption in how the program is administered. Nevertheless, when confronted with prospects of civil unrest relating to rising food prices, political leaders may judge subsidies the easiest means of placating a restive population. Second, this will also mean that existing subsidy programs will likely remain in place while food prices continue to rise. In the past couple of years, countries as disparate as Bolivia, Nigeria, and Tunisia have experienced civil unrest following decisions to reduce or eliminate subsidies on food, fuel, and other staples. The prospects of similar disruption to internal security will be fresh in the minds of many governments. Countries that do choose to abolish subsidies are likely to confront considerable resistance when doing so. Finally, the effects of this issue are not limited to smaller developing economies but **could generate political upheaval in** some of the world’s most important economies, including **China, Russia, and India.** It is widely acknowledged that food price inflation is an issue of significant political sensitivity in China and any sustained increase in food prices could cause grave concern in China’s Communist government. In Russia, similar inflationary trends could impact hardest upon the rural and poorer parts of the country on which President Vladimir Putin traditionally relies for support. Protest movements against Putin have previously lacked momentum due to his ongoing support in Russia’s hinterland; however, an erosion in support for his government in those parts of the country could alter that dynamic. However, the potential consequences of food price insecurity would perhaps be most deeply problematic for India, whose government is already struggling with the challenge of restoring order following the eruption of sectarian violence in the north-eastern Assam state. Any civil unrest related to rising food prices would present the government with a further substantial challenge to its attempts to sustain the country’s economic growth and attract further foreign investment capital.

#### Russian instability causes global nuclear war

Dimitri Simes, Senior Associate, Carnegie Endowment for International Peace, “The Return of Russian History,” FOREIGN AFFAIRS, January/February 1994, p. 67+, LN.

For the United States, neither Yeltsin's political future nor even the future of Russian democracy should be ends in themselves. What the United States needs most in its greatly weakened but still potentially formidable superpower rival is a combination of domestic stability and a system of checks and balances.Stability is important for a nation with thousands of nuclear weapons and continuing territorial tensions with its newly independent neighbors. Too much disunity in Russia (as appealing as it is to those who "love" that country so much that they would prefer to see several Russias) increases the likelihood of a civil war that could easily engulf most, if not all, of the post-Soviet states, creating not only nuclear and environmenta ldisasters but a grave threat to world peace as well. Thus, it is in the U.S. interest to have a government in Moscow that is strong and determined enough to draw the line and to prevent centrifugal, separatist trends from going out of control.Conversely, the more stable the Russian government, the more the United States should be interested in seeing that there are meaningful checks and balances to prevent the reemergence of a unitary authoritarian state. Without such checks and balances, there would be no assurance that Russia would not again become a threat to its neighbors and a destabilizing factor in world politics. The United States has a vested interest in seeing Russian governments rely more on democratic legitimacy than on the support of the military and security services.

#### china instability causes nuke war

Herbert Yee ‘2, Assc. Prof. Government @ Hong Kong Baptist University and Ian Storey, Asst. Prof. @ the Asian-Pacific Center for Security Studies, ‘2 (China Threat: Perception, Myths and Reality, p. 5)

The fourth factor contributing to the perception of a China threat is the fear of political and economic collapse in the PRC, resulting in territorial fragmentation, civil war and waves of refugees pouring into neighbouring countries. Naturally, any or all of these scenarios would have a profoundly negative impact on regional stability. Today the Chinese leadership faces a raft of internal problems, including the increasing political demands of its citizens, a growing population, a shortage of natural resources and a deterioration in the natural environment caused by rapid industrialisation and pollution. These problems are putting a strain on the central government’s ability to govern effectively. Political disintegration or a Chinese civil war might result in millions of Chinese refugees seeking asylum in neighbounng countries. Such an unprecedented exodus of refugees from a collapsed PRC would no doubt put a severe strain on the limited resources of China’s neighbours. A fragmented China could also result in another nightmare scenario — nuclear weapons falling into the hands of irresponsible local provincial leaders or warlords.12 From this perspective, a disintegrating China would also pose a threat to its neighbours and the world.

#### independently price spike kills billions

Brown 05 [Lester Brown, President – Earth Policy Institute, ‘05, People and the Planet, “Falling Water Tables 'Could Hit Food Supply'”, 2-7 http://www.peopleandplanet.net/doc.php?id=2424]

Many Americans see terrorism as the principal threat to security, but for much of humanity, the effect of water shortages and rising temperatures on food security are far more important issues. For the 3 billion people who live on 2 dollars a day or less and who spend up to 70 per cent of their income on food, even a modest rise in food prices can quickly become life-threatening. For them, it is the next meal that is the overriding concern."

#### And, Starvation is the biggest impact—intense suffering and kills millions

Holman 99 Susan, The Hungry Body: Famine, Poverty, and Identity in Basil’s Hom.Journal of Early Christian Studies 7:3, 337–363 © 1999 The Johns Hopkins University Press. Project Muse

Hunger, by which I here mean an acutely perceived physical need for food,14determines bodily processes perhaps more than any other characteristic of poverty. Further, hunger may shape not only the physical body of starving individuals but also the interactive dynamics of the starving group in the larger social body of the community.15 Whether famine in Cappadocia was rare or not, Basil implies in Hom. 8 that mortality from starvation was soon a serious and visible problem. The famine hunger Basil depicts is, as he sees it, the supreme human calamity, a more miserable end than all other deaths. For when one considers other life-threatening calamities, the sword brings a quick end; fire too extinguishes life shortly; and also wild beasts, as they rend the limbs apart with their teeth inflict fatal wounds which assure that distress will not be prolonged. But famine is a slow evil, always approaching, always holding off like a beast in its den. The heat of thebody cools. The form shrivels. Little by little strength diminishes. Flesh stretches across the bones like a spider web. The skin loses its bloom, as the rosy appearance fades and blood melts away. Nor is the skin white but rather it withers into black. . . . The knees no longer support but drag themselves by force, the voice is powerless . . . eyes sunken as if in a casket, like dried-up nuts in their shells; the empty belly collapsed, conforming itself to the shape of the backbone without any natural elasticity of the bowels. The person who rushes by such a body, how greatly worthy is he of chastisement? What excess of cruelty will he allow? Should he not be reckoned with the savagery of the beasts, accursed and a homicide?16 This involuntary starvation effects a different set of individual and social dynamics from what one finds in ascetic fasting, that individual choice undertaken for personal spiritual benefit. The starvation that results from famine and food shortage is at odds with individualwill. While the ascetic choice is perceived as empowering, involuntary starvation effects dependence, self-destruction, and suffering for the entire social network, household, and family of those affected by such poverty and hunger. Where voluntary hunger constructs an ideal body, involuntary hunger destroys it. Basil’s sermon explores the long-term implications of this corporate destruction and its roots in injustice, a lack of power over both environmental and social forces.

## Advantage 3: Wastewater

#### Wastewater is an expanding problem – over a third of the global population lives on the coast – increased wastewater destroys that oceans by expanding dead zones - this leads to disease, economic decline, warming, and biodiversity loss

Vincent Sweeney, 2013, (Coordinator of the Global Program of Action for the Protection of the Marine Environment from Land Based Activities, United Nations Environment Program), “Impact of wastewater on oceans - the nitrogen and phosphorus challenge,” (these findings come from a non-technical brief delivered at the ‘Meeting on the Post-2015 Development Agenda Consultation on Water’ that took place on February 27-28, 2013), p. 1-4

People are dependent on the coasts and oceans and the resources they provide for their ¶ survival and well-being, yet these environments are under growing pressure as the bulk of ¶ the world's population lives in coastal areas, and there is a continuing trend towards its ¶ concentration in these regions: 38 per cent of the global human population live along a ¶ narrow fringe of coastal land which constitutes only 7.6 per cent of the earth’s total land ¶ area; 70 per cent of mega-cities with populations over 8 million are located on the coast. ¶ Also, the health, well-being and, in some cases, the very survival of coastal populations ¶ depend upon the health and well-being of coastal systems - estuaries and wetlands -as ¶ well as their associated watersheds. Ultimately, sustainable patterns of human activity in ¶ coastal areas depend upon a healthy marine environment, and vice versa. ¶ ¶ However, the coastal and marine environment is being degraded due to human activities ¶ on land. Indeed, the major threats to the health and productivity and biodiversity of the ¶ marine environment result from human activities on land -in coastal areas and further ¶ inland. With the ever increasing global population and increased human productive ¶ activities, the amount of wastewater is also increasing. Also, direct discharge of ¶ wastewater into surface and groundwater systems with little or no treatment is one of the ¶ most serious threats to water resources. According to the Sick Water report ‘The central ¶ role of wastewater management in sustainable development’ (UNEP & UN-Habitat, ¶ 2010), up to 90 % of wastewater flows untreated into densely populated coastal areas, ¶ resulting in the receiving water bodies (rivers, lakes, groundwater and coastal waters) ¶ having excessive nutrient and organic materials as well as other contaminants such as ¶ persistent organic pollutants and heavy metals. ¶ ¶ Most developing countries and countries in transition have yet to reach full-capacity ¶ wastewater treatment. Currently, most of the wastewater infrastructure in many of the ¶ fastest growing cities is lacking or outdated, not designed to meet local conditions, poorly ¶ maintained and entirely unable to keep pace with rising urban populations. Further, ¶ policies and regulatory measures that encourage wastewater treatment and reuse of ¶ treated wastewater are lacking. ¶ Unregulated discharge of wastewater undermines biological diversity, natural resilience ¶ and the capacity of the planet to provide fundamental ecosystem services, impacting both ¶ rural and urban populations and affecting sectors from health to industry, agriculture, ¶ fisheries and tourism. ¶ Run-off from wastewater irrigation systems drains into surface water, particularly small ¶ confined lakes and water bodies and the remains of nutrients may cause eutrophication1¶ , ¶ particularly if phosphates in the orthophosphate form are present. Imbalances in the plant ¶ microbiological communities of water bodies may in turn affect other higher forms of ¶ aquatic life and reduce biodiversity. If these water bodies serve local communities the ¶ ecological impacts can be translated into economic impacts, which should be considered. ¶ Global loss of ecosystem services due to eutrophication is estimated to be USD 200 ¶ billion/year. In the north east of Australia, run-off of agricultural herbicides caused the ¶ loss of 30 km2¶ of mangrove between 1999 and 2002. In the Black Sea, eutrophication ¶ resulted in an annual decline of USD 360 million/year of tourism revenue (Ibrahim ¶ Thiaw, pers. Communication, UNSGAB meeting 2012). ¶ ¶ The climate is also being impacted by wastewater discharge. In fact, healthy coastal ¶ ecosystems decrease vulnerability to climate change effects and extreme events, and save ¶ e.g. infrastructure related costs. Healthy mangroves, sea grass beds and salt marshes are ¶ globally important Carbon sinks, but become sources of emissions when degraded. ¶ Wastewater-related emissions of methane (CH4), a powerful global warming gas, and ¶ another called nitrous oxide (N2O) could rise by 50 per cent and 25 per cent respectively ¶ between 1990 and 2020. ¶ ¶ The contents and significance of wastewater vary greatly between and even within ¶ regions. In developing countries, it is the impact on people‘s health that is the major ¶ factor. It is estimated that, over half of the world’s hospital beds are filled with people ¶ suffering from water related diseases while some 2.2 million people die each year from ¶ diarrhoeal conditions: 1.8 million of them are children under 5 years old. ¶ ¶ In developed countries the input of nutrients into the coastal waters reduces productivity ¶ and contributes to the rapid growth of de-oxygenated dead zones in the world’s seas and ¶ oceans. Such discharges are part of the reason why de-oxygenated dead zones are ¶ growing rapidly in the seas and oceans and are now a global concern. In 1960 there were ¶ 9 documented hypoxic zones. The number of hypoxic areas has doubled every decade ¶ since then. In 2007, a panel of experts convened under the auspices of the World ¶ Resources Institute identified 415 eutrophic and hypoxic coastal systems covering more ¶ than 245,000 km2¶ of water area worldwide (Diaz and Rosenberg, 2008), with impacts on ¶ fisheries, livelihoods and the food chain. Healthy coral reefs can produce up to 35 tons ¶ of fish per square kilometer each year and around 275 million people depend directly on ¶ coral reefs for livelihoods and sustenance. There is a catch reduction of 67 tons for every ¶ square kilometer of clear-cut mangrove forest. ¶ The costs related to the pollution of coastal waters can be significant. Undermining ¶ coastal ecosystems providing services are estimated to be worth more than 25 000 billion ¶ USD every year (Martinez et al, 2007). The millennium ecosystem assessment report suggests these to be $16 billion annually, and much of this is due to impacts on human ¶ health.2¶ While pollution is costly, the same report suggests that the economic value of ¶ the goods and services delivered by healthy coasts and oceans are worth trillions of ¶ dollars: 61 per cent of the world’s total economic output of approximately $44 trillion ¶ comes from areas within 100 kilometres of the coastline. If the pollution of coastal waters ¶ can be linked to impacts on human health and could result in a decline in the economic ¶ value derived from the coasts and oceans, the deterioration of coastal and marine ¶ environments must also contribute to rising poverty levels. The situation is likely to get ¶ worse unless there is urgent action to manage wastewater better. The world’s coastal ¶ population is increasing and by 2030, close to five billion people will live in towns and ¶ cities, many within 60 kilometers of the coast; and by 2050 the global population will ¶ exceed nine billion. Some of these trends are inevitable, but the world can still choose the ¶ quantity and quality of discharges to rivers and seas if a sustainable link is made from ¶ cities, rural areas and farms, to the ecosystem services surrounding them. Investment in ¶ improved sanitation and water treatment technologies will pay multiple dividends. ¶ Similarly, investment in rehabilitating and restoring nature‘s own water purification ¶ systems—such as wetlands and mangroves— will be cost effective. ¶ ¶ Inadequate treatment and a lack of ecosystem-based and resource-recycling approaches to ¶ wastewater management, not only impacts the environmental conditions and ecosystem ¶ services of receiving water bodies, but also lead to lost opportunities to reuse and recycle ¶ nutrients, water and other materials for agricultural production and water supply. Also, a ¶ series of demonstration activities to utilize organic materials found in wastewater to ¶ produce biogas for energy and heat generation clearly exhibited climate change related ¶ benefits connected with the climate change related funding mechanisms. It was ¶ confirmed that a number of approaches, such as dry toilets and industrial water use ¶ efficiency improvement, can reduce water used in wastewater systems. All in all, ¶ wastewater is an important resource to be wisely used for economic benefits of concerned ¶ populations. Reducing unregulated discharge of wastewater and securing safe water are among the ¶ most important interventions for improving global public health and achieving ¶ sustainable development. The knowledge and the technology exist. The key to success ¶ must blend immediate action and long term thinking, and bring wastewater into the ¶ dialogue of wider planning and management. Solutions must be innovative, bringing ¶ together partnerships between private and public sectors. Successful and sustained ¶ wastewater management will need an entirely new dimension of investments, to start now. ¶ ¶ Experiences have shown that appropriate investments done in the right manner can ¶ provide the required returns. However, it will require not only investments, but careful ¶ and comprehensive integrated water and wastewater planning and management at ¶ national and municipal levels. This must transcend the entire water supply and disposal ¶ chain involving ecosystem management (including coastal waters), agricultural efficiency ¶ and production and treatment of wastewater and a stronger focus on urban planning. Meeting the wastewater challenge is not a luxury but a prudent, practical and ¶ transformative act, able to boost public health, secure the sustainability of natural ¶ resource and trigger employment in better, more intelligent water management.

#### Dead zones are expanding global – that crushes oceanic biodiversity

Fanney 14 (Robert Fanney is an environmentalist advocate featured in the national geographic) January 21, 2014 “Awakening the Horrors of the Ancient Hothouse — Hydrogen Sulfide in the World’s Warming Oceans” https://robertscribbler.wordpress.com/tag/ocean-dead-zones/

The world’s oceans, according to recent research, are rapidly becoming more stratified and less oxygen-rich. The result is that mixing between various layers of the ocean is beginning to shut down reducing oxygen content in the deep ocean and spurring the expansion of numerous oceanic dead zones. Over the past 150 years, the Pacific Ocean was observed to become more stratified at a pace ten times that seen during the end of the last ice age about 12,000 years ago. Such a rapid pace of stratification is putting severe stress on the world’s oceans with numerous regions showing the effects of low oxygen (hypoxia) and some regions succumbing to increasingly anoxic states.¶ These low oxygen events have been associated with multiplying oceanic dead zones. Very large dead zones have been observed in the Pacific, specifically off the coast of Oregon. Other major dead zones continue to be observed at the mouth of major river systems, such as within the Gulf of Mexico, where the appearance of massive related toxic algae blooms is now an almost annual event. In general, almost all ocean dead zones are expanding leading to the dramatic reduction in habitat size of numerous fish species. And even the most cursory research provides ample evidence that ocean hypoxia is expanding concurrently with a rapidly expanding ocean stratification.¶ When combined with the jarring effects of rapid ocean warming and expanding acidification, it becomes plainly obvious to almost any ocean ecologist that the world’s ocean system is suffering the heavy bombardment of a new mass extinction event.

#### Oceans are key to global survival – resiliency becomes impossible - causes extinction

Science Daily, 8/20/12, “World's Sea Life Is 'Facing Major Shock', Marine Scientists Warn” <http://www.sciencedaily.com/releases/2012/08/120821094452.htm>

Life in the world's oceans faces far greater change and risk of large-scale extinctions than at any previous time in human history, a team of the world's leading marine scientists has warned.The researchers from Australia, the US, Canada, Germany, Panama, Norway and the UK have compared events which drove massive extinctions of sea life in the past with what is observed to be taking place in the seas and oceans globally today.¶ Three of the five largest extinctions of the past 500 million years were associated with global warming and acidification of the oceans -- trends which also apply today, the scientists say in a new article in the journal Trends in Ecology and Evolution.¶ Other extinctions were driven by loss of oxygen from seawaters, pollution, habitat loss and pressure from human hunting and fishing -- or a combination of these factors."Currently, the Earth is again in a period of increased extinctions and extinction risks, this time mainly caused by human factors," the scientists stated. While the data is harder to collect at sea than on land, the evidence points strongly to similar pressures now being felt by sea life as for land animals and plants. The researchers conducted an extensive search of the historical and fossil records to establish the main causes of previous marine extinctions -- and the risk of their recurring today.¶ "We wanted to understand what had driven past extinctions of sea life and see how much of those conditions prevailed today," says co-author Professor John Pandolfi, of the ARC Centre of Excellence for Coral Reef Studies and The University of Queensland, an authority on the fate of coral reefs in previous mass extinction events.¶ "It is very useful to look back in time -- because if you forget your history, you're liable to repeat it."¶ Marine extinction events vary greatly. In the 'Great Death' of the Permian 250 million years ago, for example, an estimated 95 per cent of marine species died out due to a combination of warming, acidification, loss of oxygen and habitat. Scientists have traced the tragedy in the chemistry of ocean sediments laid down at the time, and abrupt loss of many sea animals from the fossil record.¶ "We are seeing the signature of all those drivers today -- plus the added drivers of human overexploitation and pollution from chemicals, plastics and nutrients," Prof. Pandolfi says.¶ "The fossil record tells us that sea life is very resilient -- that it recovers after one of these huge setbacks. But also that it can take millions of years to do so."¶ The researchers wrote the paper out of their concern that the oceans appear to be on the brink of another major extinction event.¶ "There may be still time to act," Prof. Pandolfi says. "If we understand what drives ocean extinction, we can also understand what we need to do to prevent or minimize it.¶ "We need to understand that the oceans aren't just a big dumping ground for human waste, contaminants and CO2 -- a place we can afford to ignore or overexploit. They are closely linked to our own survival, wellbeing and prosperity as well as that of life on Earth in general.¶ "Even though we cannot easily see what is going on underwater, we need to recognise that the influence of 7 billion humans is now so great it governs the fate of life in the oceans. And we need to start taking responsibility for that."¶ He adds "The situation is not hopeless. If fact we have seen clear evidence both from the past and the present that sea life can bounce back, given a chance to do so.¶ "For example, in Australia we have clear evidence of that good management of coral reefs can lead to recovery of both corals and fish numbers.¶ "So, rather, our paper is an appeal to humanity to give the oceans a chance.¶ "In effect, it says we need to stop releasing the CO2 that drives these massive extinction events, curb the polluted and nutrient-rich runoff from the land that is causing ocean 'dead zones' manage our fisheries more sustainably and protect their habitat better.¶ "All these things are possible, but people need to understand why they are essential. That is the first step in taking effective action to prevent extinctions."

#### The plan creates a model – OMEGA can clean up coastal wastewater globally

Jonathan Trent, 6/21/2013, Planet OS, (Interview, conducted by Nico Danan), “NASA OMEGA project: the ocean as a platform for biofuel,” <http://blog.planetos.com/nasa-omega-project-the-ocean-as-a-platform-for-biofuel/>

[Q]: Why are biofuels not viewed as a viable alternative to fossil fuels?¶ [A]: Biofuels could be a long term, sustainable alternative to fossil fuels, but only if they are produced in sufficient quantities to meet the demand, with a price at the pump that people will tolerate, and without competing with agriculture for water, fertilizer, or land. These three issues of scale, economics, and competition with agriculture, are why people have lost faith in biofuels. But if there were a way to produce huge quantities of cheap biofuels that didn’t compete with food production, it would be a different story.¶ When I analyzed where we could produce biofuels and make it scalable, affordable and not compete with agriculture, I realized OMEGA is the answer. That is, we need to move offshore. More specifically, using photobioreactors floating in protected bays to grow microalgae on the wastewater from coastal cities currently dumped offshore. This way we address the issues of scale and competition with agriculture. Think about it. There’s plenty of space offshore and with sea level rise there will be new opportunities to make large-scale OMEGA systems.¶ [Q]: Since you last spoke at TED, how has the OMEGA project progressed?¶ [A]: I spoke at TED in June 2012 and in December I completed a three-year, $10.8 million feasibility study that was funded by NASA and the California Energy Commission. My TED talk is an overview of our accomplishments. The details will be published in a series of technical papers that are still in the works.¶ The goal is to share our results with everyone interested in developing OMEGA systems, so they can build on our accomplishments and won’t have to make the same mistakes we made. Given the desperate need for alternatives to fossil fuels and the potential of the OMEGA system, ideally everyone will share information to expedite OMEGA developments, exactly like an open source software development.¶ Since TED, I have also been looking for a way to go on to the next step of OMEGA, which I think is the deployment of a 1-acre demonstration of an integrated system floating in a protected bay somewhere. The integrated system includes algae cultivation for wastewater treatment and carbon capture, as well as electricity generation by solar. It also includes wind, wave power systems, and food production by a compatible aquaculture activity.¶ I have been talking to a lot of people at relevant organizations in various countries about the first deployment of an integrated OMEGA system. I think it’s critical to focus on an ocean deployment in a bay, not just to continue lab work. We can continue lab work for decades, but it’s important that we scale this up quickly and prove that it is commercially viable. This is not the way scientist usually work. Most scientists don’t solve problems, they colonize them and can study the subtleties of interesting problems for years. OMEGA is meant to address real-world problems and it must develop quickly.

#### OMEGA is foolproof system to clean up wastewater and deadzones

Teague Soderman 12 “Offshore Membrane Enclosure for Growing Algae (OMEGA)” http://sservi.nasa.gov/articles/omega/

When deployed in contaminated and “dead zone” coastal areas, this system may help remediate these zones by removing and utilizing the nutrients that cause them. The forward-osmosis membranes use relatively small amounts of external energy compared to the conventional methods of harvesting algae, which have an energy intensive de-watering process. Potential benefits include oil production from the harvested algae, and conversion of municipal wastewater into clean water before it is released into the ocean. After the oil is extracted from the algae, the algal remains can be used to make fertilizer, animal feed, cosmetics, or other valuable products. This successful spinoff of NASA-derived technology will help support the commercial development of a new algae-based biofuels industry and wastewater treatment.¶ “The reason why algae are so interesting is because some of them produce lots of oil,” said Jonathan Trent, the lead research scientist at NASA Ames Research Center, Moffett Field, Calif. “In fact, most of the oil we are now getting out of the ground comes from algae that lived millions of years ago. Algae are still the best source of oil we know.”¶ Algae are similar to other plants in that they remove carbon dioxide from the atmosphere, produce oxygen as a by-product of photosynthesis, and use phosphates, nitrogen, and trace elements to grow and flourish. Unlike many plants, they produce fatty, lipid cells loaded with oil that can be used as fuel.¶ “The inspiration I had was to use offshore membrane enclosures to grow algae. We’re going to deploy a large plastic bag in the ocean, and fill it with sewage. The algae use sewage to grow, and in the process of growing they clean up the sewage,” said Trent.¶ It is a simple, but elegant concept. The bag will be made of semi-permeable membranes that allow fresh water to flow out into the ocean, while retaining the algae and nutrients. The membranes are called “forward-osmosis membranes.” NASA is testing these membranes for recycling dirty water on future long-duration space missions. They are normal membranes that allow the water to run one way. With salt water on the outside and fresh water on the inside, the membrane prevents the salt from diluting the fresh water. It’s a natural process, where large amounts of fresh water flow into the sea.¶ Floating on the ocean’s surface, the inexpensive plastic bags will be collecting solar energy as the algae inside produce oxygen by photosynthesis. The algae will feed on the nutrients in the sewage, growing rich, fatty cells. Through osmosis, the bag will absorb carbon dioxide from the air, and release oxygen and fresh water. The temperature will be controlled by the heat capacity of the ocean, and the ocean’s waves will keep the system mixed and active.¶ When the process is completed, biofuels will be made and sewage will be processed. For the first time, harmful sewage will no longer be dumped into the ocean. The algae and nutrients will be contained and collected in a bag. Not only will oil be produced, but nutrients will no longer be lost to the sea. According to Trent, the system ideally is fail proof.

# Case Extensions

## Inherency

### Funding

#### The OMEGA project needs more funding

Jason Hoppin, 5/18/2012, Santa Cruz Sentinel, “a green future: NASA’s $10 million project explores algae as fuel source,” <http://www.santacruzsentinel.com/ci_20658615/green-future-nasas-10-million-project-explores-algae>

"We've got to move quickly because we don't have much time to figure out how this is going to work," Trent said, citing problems with the country's reliance of foreign energy sources.¶ If you haven't heard much about the project, there's a reason for that. The researchers have kept a low profile since NASA head Charles Bolden questioned the project's viability - questions Bolden admitted he raised after discussions with Marathon Oil Corp., a company with which he had ties.¶ Algae's potential as a fuel source is not a new idea, nor are plant-based alternatives to fossil fuels. Corn-based ethanol, after all, already supports a thriving (though controversial) industry.¶ But algae has been met with some controversy. Even though a 2011 Department of Energy study found that algae could replace about one in every six barrels of oil imported into the U.S., skeptics remain.¶ Even when President Obama praised its potential during an energy speech earlier this year, he pledged to spend only $14 million on new algae research - not much more than the OMEGA Project's funding.

#### OMEGA needs more investment

Hoppin 12 (JASON HOPPIN – Staff writer at Santa Cruz Sentinel. “A green future: NASA's $10 million project explores algae of as fuel source” 5/18/12 http://www.santacruzsentinel.com/ci\_20658615/green-future-nasas-10-million-project-explores-algae)//EAZYE

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#### Algae biofuels needs more investment to reach commercialization

Madrigal 09 (Alexis Madrigal. Contributer to Wired Science. 12/29/09. “How Algal Biofuels Lost a Decade in the Race to Replace Oil” <http://www.wired.com/wiredscience/2009/12/the-lost-decade-of-algal-biofuel/)//EAZYE>

Just $25 million was invested over the of the Aquatic Species Program, which is just 5.5 percent of the total money the DOE dedicated to biofuels over that time. Adjusted for inflation, the program’s total budget in today’s dollars was less than $100 million. To put this tiny number in oil industry context, Exxon Mobil made [$142 million in profit each day of 2008](http://www.google.com/finance?client=ob&q=NYSE:XOM).“They came up with this idea and in four years, they almost demonstrated the technological feasibility, and then the funding fell out,” said Johansen, the phycologist who collected algae for the program. “The maximum of funding was about $4 million a year. When I left, it was $800,000 a year. Now, there is all this biofuel work going on, and they are all going back to that public domain research. It kind of drives me crazy.”The neglect of the Aquatic Species Program and subsequent resurgence of algal biofuel interest is one of many examples that show that the lack of coherent, consistent energy policy has left the world’s most oil-dependent nation scrambling in times of crisis.Johansen even went so far as to say that “if the Reagan and Bush administrations had not ended” the growth of the algal biofuels program, our country would have algal biofuels now.

### Need a Demonstration Project

#### OMEGA needs a demonstration project, but it lacks financing

Trent 13

(http://www.energynext.in/wp-content/uploads/2013/05/May-2013-EN.pdf, Target 2017: Racing ¶ against time EXPERT SPEAK¶ Dr Jonathan Trent)//BSpencer

I **have just completed a $10.8 million feasibility study funded by NASA** and ¶ the California Energy Commission ¶ **and I’m working on a series of** ¶ **technical papers to share the results** ¶ **with everyone interested.** **There** ¶ **is not currently any organization** ¶ **funding my interest in doing a** ¶ **scaled-up demonstration of an** ¶ **OMEGA system, but I’m talking to** ¶ **lots of people in various countries** ¶ **and I’m optimistic that I may be part** ¶ **of further developments in OMEGA.** ¶ **What’s important is that someone** ¶ **starts, somewhere, so others will have** ¶ **a model to follow!**

#### Algae biofuel commercialization is stunted by the lack of a viable demonstration project – expanding OMEGA is key

SciTech Daily 2012

"NASA Explores OMEGA System for Alternative Aviation Fuels." *SciTech Daily*. N.p., April 17, 2012Web. 22 June 2014. <http://scitechdaily.com/nasa-explores-omega-system-for-alternative-aviation-fuels/>

Algae do not currently contribute significantly to biofuel production because of logistical and economic issues. Large-scale algae farms (millions of acres) will require huge pipelines for wastewater and CO2, the farm infrastructure, and a transportation network for the diverse products. On land, neither the required energy nor the economic returns on investment can be met. It is not known if OMEGA, using existing offshore wastewater outfalls, coastal CO2 sources, ships, and local energy sources can meet the required returns. At this stage OMEGA warrants further investigations.¶ The next step is for other organizations to deploy larger-scale systems offshore in protected bays to determine if OMEGA can be used commercially for biofuels production, environmental remediation, wastewater treatment or carbon sequestration.¶ The detailed results of the investigations will be published in scientific journals and made publicly available in the near future. The next step is for others to deploy larger-scale systems in protected bays to determine if OMEGA can be used commercially for biofuels production, environmental remediation, wastewater treatment and carbon sequestration.

## Solvency

### Financial Incentives – Commercialization Solvency

#### Financial incentives for algae biofuels bring down production costs

Ken Silverstein, 5/20/2012, Forbes, “will algae biofuels hit the highway?” <http://www.forbes.com/sites/kensilverstein/2012/05/20/will-algae-biofuels-hit-the-highway/2/>

What would help the sector get there faster? Algae bio-fuels producers are asking U.S. lawmakers to treat their product the same way as they do other advanced bio-fuels such as cellulosic ethanol. That means including algae in the tax incentives given to advanced bio-fuels and in the Renewable Fuels Standard that sets alternative fuel targets. When the code was written, algae was a nascent concept that never wound up on anyone’s radar.¶ Legislation has just been introduced in the U.S. House to achieve just that. With such tax incentives, the industry says that production costs would come down. Those costs are now considered to be at least double that of petroleum-based fuels, although such figures can vary with location, technology and whether the algae plant can be located near existing power plants or oil refineries so as to capture their carbon emissions.

#### Algae-based biofuels do not receive the same financial incentives relative to other biofuels – increased incentives will grow the industry

Kelsi Bracmort, 1/30/2014, Congressional Research Service, “Algae’s potential as a transportation biofuel,” <http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R42122.pdf>

Congress is currently questioning whether existing policies are leading to the expanded use of¶ domestic advanced biofuels—including algae-based biofuels (ABB), among other options. In the¶ Energy Independence and Security Act of 2007 (EISA, P.L. 110-140), Congress expanded the¶ Renewable Fuel Standard (RFS2) by mandating that increasing volumes of renewable biofuels be¶ used in the nation’s transportation fuel supply.1 The RFS2 identified four specific biofuel¶ categories and established time-specific mandates for quantities of fuels, the fastest-growing and¶ largest of which is the cellulosic biofuels category. Algae is not identified as a cellulosic biofuel¶ feedstock type to meet the RFS2 (Renewable Fuel Standard).¶ According to RFS compliance data monitored by the U.S. Environmental Protection Agency¶ (EPA), a steady production of small amounts of cellulosic biofuel began in mid-2013. As a result¶ of the small amounts produced, EPA was compelled to lower the cellulosic biofuel mandate for¶ the fourth successive year and has proposed to do so for a fifth year in 2014. Moreover, the longterm¶ certainty of the tax incentives for which (algae-based biofuels) ABB is eligible is debatable.2 There is considerable¶ concern about how the U.S. cellulosic biofuels industry will develop to meet the mandates in the¶ absence of federal support and which, if any, other types of biomass could be used as a primary¶ feedstock to meet the mandate.¶ Thus far, legislation pertaining to algae-based biofuels has not been introduced in the 113th¶ Congress. Congress held hearings and Members introduced legislation during the 112th Congress¶ that supported the use of multiple biomass feedstocks as energy sources to meet transportation¶ needs.3 Of particular interest are feedstocks that are sustainable and domestic in origin, could spur¶ job creation, and would have few adverse environmental impacts. Some argue that algae—¶ generally defined as simple photosynthetic organisms that live in water—is one biomass¶ feedstock that could meet these criteria. Algae can be used to produce a variety of biofuels, but¶ most production to date has focused on biodiesel and jet fuel, and it is unclear whether production¶ of other biofuels would be feasible given resource requirements and other concerns.¶ If successfully commercialized, ABB would have potential advantages and disadvantages¶ compared to other biofuels. Among its advantages, algae has higher biomass yields per acre of¶ cultivation than other feedstocks, leading to larger oil yields. It also may use water that is¶ undesirable for other uses (e.g., wastewater or saline sources). In addition, ABB production could¶ potentially use carbon dioxide from the flue gas of stationary sources (e.g., power plants), if ABB¶ facilities are co-located with such facilities.4 Some ABB drawbacks concern the cost of running a¶ commercial-scale facility, the volume and availability of resource inputs (e.g., water, land, and¶ nutrients), the immaturity of technology to convert algae into biofuels, and the sensitivity of algae¶ to minor changes in its environment.¶ Substantial ABB research and development (R&D) has taken place since the 1950s, but for¶ various reasons ABB has yet to gain a foothold in the transportation fuel market. The main reason¶ is that ABB is not currently economical to produce at commercial scale. Also, it is not a major¶ component of energy and agricultural statutes; as a result there is likely more inherent investment¶ risk. The relevance of ABB to the U.S. transportation sector could potentially rise if technological¶ advances are achieved, if oil prices rise, if certain fuels (e.g., cellulosic biofuels) prove incapable¶ of meeting annual RFS2 mandates, or as federal agencies and corporations announce ventures¶ involving ABB for both vehicle and aircraft use.

#### Algae biofuels do not receive the same level of financial incentives as other biofuels – creating tax parity will drive commercialization

Mary Rosenthal, 3/31/2011, Biofuels Digest, “Leveling the playing field for algae-based biofuels,” <http://www.biofuelsdigest.com/bdigest/2011/03/31/leveling-the-playing-field-for-algae-based-fuels/>

Algae-based fuels not afforded the same incentives as other renewable fuels¶ Our federal tax policy actually discourages the production of low-carbon, renewable algae-based fuels, including drop-in gasoline, diesel, and jet fuel, as well as ethanol, by failing to provide them the same incentives accorded to other advanced biofuel feedstocks.¶ For example, the Renewable Fuel Standard, an essential tool in our nation’s efforts to develop a domestic biofuels industry, currently excludes algae-based biofuels from nearly 80% of the advanced biofuels mandate. None of the major tax incentives for the production of advanced biofuels clearly and fully apply to the production of most-algae based fuels.¶ This lack of parity, where some feedstocks are favored and others like algae go unrecognized, acts as a significant impediment to the industry’s growth. Instead, the government should encourage the development of the algae industry, given how algae can be grown on non-agricultural land using salt water or wastewater, consume carbon dioxide as they grow, and produce oil more efficiently than any other known process, making them a highly scalable and productive feedstock.¶ Instead, the current legislative regime deters the algae industry’s growth by making it difficult to attract the private capital required to construct commercial-scale production facilities.¶ This unlevel playing field is mostly the result of timing. When the Renewable Fuels Standard and renewable fuel production tax credits were first established, the algae-to-biofuels industry was still nascent and algae-based fuels were not included.¶ 100 algae-to-biofuels companies¶ But times have changed. Between 2005 and 2009, the number of algae-to-biofuels startups more than tripled, there are now more than 100 companies across the value chain in the United States and several demonstration- and commercial-scale facilities breaking ground this year. That is why it is essential these promising technologies be integrated into the existing policy framework.¶ The Bilbray Bill levels the playing field¶ Fortunately, a bipartisan group of lawmakers are focused on addressing this challenge. Legislation introduced last week by Rep. Brian Bilbray (R-CA.) would take an important step towards achieving a technology neutral biofuels policy. The bill, H.R. 1149, would expand the $1.01 per gallon cellulosic biofuels tax credit to algae-based biofuels. It would also amend the Clean Air Act by adding algae- based biofuels to the definition of cellulosic biofuels, so that algae-based fuels can help meet the 16 billion gallon carve-out for cellulosic biofuels in the Renewable Fuel Standard.¶ Bi-partisan support¶ Congressman Bilbray’s bill has strong bipartisan support from Reps. Roscoe Bartlett (R-MD), Mary Bono Mack (R-CA), Russ Carnahan (D-MO), Susan Davis (D-CA) David Dreier (R-CA), Duncan Hunter (R-CA) and Jay Inslee (D-WA), reflecting algae’s appeal as a promising energy crop that can bolster America’s energy security. H.R. 1149 is also an instructive example of how members of Congress can work across the aisle to craft modest, targeted legislation that provides a technology-neutral policy environment. In doing so, Congress can further accelerate the commercial development of next-generation biofuels, including those derived from algae.

### RFS = Financial Incentives

#### The RFS is a financial incentive

Karlen 14 “Cellulosic Energy Cropping Systems,” Douglas L. Karlen. 2014. (http://books.google.com/books?id=y9TnAgAAQBAJ&pg=PA39&lpg=PA39&dq=(%22renewable+fuel+standard%22+AROUND+(25)+%22financial+incentive%22)&source=bl&ots=x6Lpoj5iqa&sig=RJlho-D9r5Y8Bum2ebEdlmakF7g&hl=en&sa=X&ei=UXWrU5WqKdOayATx44GYBA&ved=0CB0Q6AEwAA#v=onepage&q=financial%20incentive&f=false)

There are a number of drivers that are pushing industry to adopt biopower technologies, including the Renewable Fuel Standard and the Renewable Portfolio Standards [30.3ll. These policies give a financial incentive to produce bioenergy. ln spite of these policies, the increase in bioenergy production has not accelerated as expected. There are a variety of barriers that need to be addressed for the bioindustry to succeed. These include:¶ o Access to low cost sustainable biomass.¶ o Additional research into technologies that increase efficiencies and decrease operational costs.¶ o Additional policies and incentives. such as a C01 lax.¶ The bioenergy industry has already proven to have a place in the overall energy portfolio and will continue to grow. The only questions are how fast and in what direction.

### Demonstration – Commercialization Solvency

#### Successful demonstrations draw private investment – proves it is commercially viable

Jeffrey Decker, 6/22/2009, Renewable Energy World, “Blooming biofuel: how algae could provide the solution,” <http://www.renewableenergyworld.com/rea/news/article/2009/06/blooming-biofuel-how-algae-could-provide-the-solution?cmpid=WNL-Wednesday-June24-2009>

The environmental advantages of algae – which absorb CO2 along with nitrates and phosphates – are coupled with the promise of commercial yields of high quality biofuel. An indication of this potential is given by the growth of interest in the sector. According to Otto Pulz and his colleagues at the IGV Institute in Potsdam, Germany, the 100,000 known strains of microalgae in the world are currently being scrutinized by at least 200 companies with big plans. At first count, in 2007, there were just five. ‘Mainly in the U.S., it’s concentrated there,’ he says, with European interest next.¶ Pulz, whose company’s own plans include a 100 hectare facility, notes that American investors were giving three times what Europeans were, despite the fact that significant quantities are unlikely to be sold by anyone for two years, and perhaps longer now that global investments are drying up. For instance, Smorgen Fuels of Melbourne, Australia, which had hoped to sell biodiesel from algae this year, have been forced to announce that the programme has been delayed. ‘It might be another 18 months to a couple of years,’ states business development manager Nelun Fernando. ‘Everything is new, except, of course, for the algae.’¶ Nonetheless, despite the downturn, investors continue to emerge. ‘In the U.S.,’ says Byrne, ‘I know of about one half billion dollars that have been invested. I’ve heard claims of over a billion. Most of it’s been what we call angel investors.’¶ Bill Gates and his Cascade Investment LLC jumped behind Sapphire Energy of San Diego, helping them raise ‘substantially more than $100 million’ by September, along with ARCH Venture Partners, Wellcome Trust and Venrock. Sapphire means to produce 10,000 barrels of ‘green crude’ in three to five years.¶ Solazyme of San Francisco isn’t saying who invested $45 million in their fermentation process to grow algae in the dark. Their target to sell diesel is between next year and 2012, although testing by the global standards-setting body ASTM International has already cleared their diesel for performance and safety.¶ Being proven helps attract investments, says Adeo Ressi, founding member of Thefunded.com. ‘If you have a company that’s already financed, the likelihood of it being able to receive more money is significantly higher than a new entrant’, he says. ‘Outside of inventing cold fusion, it’s going to be very, very difficult, if not impossible, for new companies to find financing.’ He notes: ‘One nice thing about algae compared to solar and some other clean tech ideas, is that by comparison it can be much more capital efficient.’

#### A demonstration is key to a commercial spillover.

Loury 2011

(Algae experiment may be 'game changer'¶ Scientists aim to create biofuel¶ By ERIN LOURY ¶ Herald Staff Writer¶ POSTED: 11/22/2011 01:26:34 AM PST0 COMMENTS| UPDATED: 3 YEARS AGO http://www.montereyherald.com/news/ci\_19389410, Date Accessed: 6.22.14)//BSpencer

First flight Scaling up the design to a commercial level may raise additional concerns for wildlife, and will require spatial planning discussions with marine stakeholders, like the fishing and shipping industries.¶ **Such future development would require additional investment because the team's current funding winds down in December. Trent hopes more support from NASA will help the team scale up the 10-foot** functioning model in Santa Cruz to a 30-foot model deployed at the San Francisco Southeast plant.¶ **Trent said the OMEGA project is seeking the equivalent of the Wright brothers' first flight. While the flight lasted only 12 seconds, it was long enough to prove a concept, and laid the foundation for flights that followed.¶ "We just need to get that 12 second flight to work," Trent said, "so other people can pick up what we started, and can bring it to the world."**

#### A 1-acre demonstration is sufficient to prove commercial viability – that leads to international adoption

Nico Danan and Dr. Jonathan Trent, (interview between Danan and Trent), 6/21/2013, Planet OS, “NASA OMEGA project: the ocean as a platform for biofuel,” <http://blog.planetos.com/nasa-omega-project-the-ocean-as-a-platform-for-biofuel/>

[Q:] Since you last spoke at TED, how has the OMEGA project progressed?¶ [A:] I spoke at TED in June 2012 and in December I completed a three-year, $10.8 million feasibility study that was funded by NASA and the California Energy Commission. My TED talk is an overview of our accomplishments. The details will be published in a series of technical papers that are still in the works.¶ The goal is to share our results with everyone interested in developing OMEGA systems, so they can build on our accomplishments and won’t have to make the same mistakes we made. Given the desperate need for alternatives to fossil fuels and the potential of the OMEGA system, ideally everyone will share information to expedite OMEGA developments, exactly like an open source software development.¶ Since TED, I have also been looking for a way to go on to the next step of OMEGA, which I think is the deployment of a 1-acre demonstration of an integrated system floating in a protected bay somewhere. The integrated system includes algae cultivation for wastewater treatment and carbon capture, as well as electricity generation by solar. It also includes wind, wave power systems, and food production by a compatible aquaculture activity.¶ I have been talking to a lot of people at relevant organizations in various countries about the first deployment of an integrated OMEGA system. I think it’s critical to focus on an ocean deployment in a bay, not just to continue lab work. We can continue lab work for decades, but it’s important that we scale this up quickly and prove that it is commercially viable. This is not the way scientist usually work. Most scientists don’t solve problems, they colonize them and can study the subtleties of interesting problems for years. OMEGA is meant to address real-world problems and it must develop quickly.

### Modeling – Commercial Demonstration Key

#### Demonstration key to spill over

Trent 13 (Dr. Jonathan Trent has a doctorate in biological oceanography)Jun 21, 2013 “NASA OMEGA Project: The Ocean as a Platform for Biofuel”

http://blog.planetos.com/nasa-omega-project-the-ocean-as-a-platform-for-biofuel/

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### Solvency – Cost Competitive With Oil

#### Algae biofuels can be cost competitive with oil – economics of scale

Koenraad Vanhoutte, (Ph.D., Science Director of SBAE Industries), 2/19/2011, Sustainable Bio-Eingineering for the Aquatic Environment Industries, “Algae for a second green revolution,” <http://webcache.googleusercontent.com/search?q=cache:8jr2kVs_cn0J:www.bioethanol.ru/download_file.php%3Fdownload_propertys_items_id%3D80412+&cd=1&hl=en&ct=clnk&gl=us>

The industrial production of diatoms or other micro-algae, and the success of the Second ¶ Green Revolution will depend on the design of new business models. Sustainable production allows ¶ for sustainable economics. To attain economic viability the business model should achieve the ¶ maximum commercial value of the entire biomass. Indeed, the key lies in obtaining the maximum ¶ value of all of the produced diatom biomass. Imagine a diatom farm of 250 acres. In temperate sunny ¶ regions this would produce say around 12,000 tons/year of total biomass. With the poly-modulation ¶ technology this would contain about 20-30% of triglyceride oil. The net yield would be around 3,000 ¶ tons of triglyceride oil and 9,000 tons of algal biomass. ¶ ¶ This residual biomass can be commercialized as a highly nutritious protein meal, loaded with ¶ residual essential fatty acids (omega 3’s), anti-oxidants, vitamins, trace elements and phytosterols. ¶ Commercialisation of this diatom meal at about $2.25-$4.50/pound allows for the diatom oil to be sold ¶ profitably at $50-$100/barrel. If the diatom business case is to succeed, the value of both the diatom ¶ oil and the diatom meal are inseparably intertwined. Both must be present in the business proposal ¶ from day one. Economic realization of the total biomass is imperative for any ‘algae to fuel’ business ¶ proposal.¶ The logic is fairly straightforward. Because petroleum, the fossil fuel, has no real production ¶ costs, diatom oil should become maximally insensitive to the production cost of the total diatom ¶ biomass. Once this is the case, then diatom oil becomes competitive in the present day market ¶ situation and can play a substantial role in the energy industry. This is achieved by allocating most or ¶ all of the production costs of the total biomass to the commercialization of the residual diatom meal. ¶ Consequently the COGS of the diatom oil drops to near zero and the price per barrel diatom oil can be ¶ determined based on other external market drivers. ¶ ¶ Obviously, such a model becomes stronger through economies of scale. Therefore, to ¶ produce diatom oil at prices competitive with fuel, the diatom production capacity must be sufficiently ¶ scaled. Given sufficient volume the diatom meal will become an important product on the marketplace. ¶ The large volumes generate a sufficiently large turnover to carry the full production cost. This raises ¶ the crucial question of the value of the diatom meal.

### Solvency – Scale Up/Quickly Increase Production

#### Algae biofuel production can quickly be scaled up

Barbara Lundin, 5/29/2011, Fierce Energy, “algae-based biofuels represent a trillion dollar potential market opportunity, but cost is an obstacle to commercialization,” <http://www.fierceenergy.com/node/88055/print>

Among next generation renewable fuel alternatives, algae stands out as one of the most promising and scalable options with the potential to supply key fuel and co-product markets. Strong demand from aviation and military consumers, technological breakthroughs in the production, cultivation, and extraction of algae oil, and the development of large-scale projects will be critical to widespread growth in the algae-based biofuels market.¶ According to a recent report from Pike Research, despite limited production to date, the scale-up potential of algae is substantial compared to other non-food based feedstocks. Although regulatory and policy uncertainty as well as competition from co-product markets will inhibit algae-based biofuels production initially, the cleantech market intelligence firm projects that the value of renewable fuels derived from algae will reach $1.3 billion by 2020.

### Solvency – Federal Action Key

#### Federal government key to alternative energy

Caperton 13 (Richard W. Caperton is managing director of energy at the Center for American Progress) Sept. 22, 2013  “Should the U.S. Finance Alternative-Energy Startups?” http://online.wsj.com/news/articles/SB10001424127887324665604579078933691163714

Later this year,BrightSource Energy Inc. will begin generating power from a new solar plant, the largest of its type in the world, based in the Mojave Desert. During the first half of this year, electric-car maker Tesla Motors Inc. TSLA +1.47% brought in nearly $1 billion in revenue, the first step in revolutionizing U.S. transportation.¶ What do these milestones have in common? They each came about because of government investment in clean-energy startups.¶ The U.S. can't afford not to invest in clean energy. Climate change caused by burning fossil fuels is one of the greatest threats to the U.S. Government can play a responsible, effective role in meeting this challenge by investing in new energy resources.¶ The Past as Proof¶ The government has a suite of investment tools, each of which serves a critical purpose. Cash grants can help a small company get started. Tax credits can help lower the cost structure for a larger company. Loans and loan guarantees can provide access to affordable debt that wouldn't otherwise exist for commercialization. The government can also invest in research and development, which can help move entire industries forward. For proofs of past success, take a trip to the Hoover Dam, one of the original government-financed energy startups. Loans from the Rural Electrification Administration, meanwhile, provided the capital necessary to bring lights to rural America.¶ Further proof can be found in the very example that opponents use to argue against a government role—that is, the idea that natural gas and free markets have already shown us the best way to reduce carbon emissions. **The truth is that government research and tax credits led to new drilling techniques that are at the heart of today's natural-gas boom.**¶ **What's more, despite what some may say, regulations do not hold back innovation at traditional energy companies. Many are just unwilling to help meet the challenges of the future.** Oil companies, in particular, tend to use profits for share repurchases rather than long-term investments in innovation.¶ Electricity from wind and solar, meanwhile, has more than doubled since 2008. Production costs continue to tumble with minimal expense to the Treasury. And contrary to popular belief, the government actually has a remarkable track record of investing in specific companies. The Department of Energy's Loan Programs Office invests in specific companies based on a careful evaluation of financials, technologies, management and other key variables. TALE OF TWO STARTUPS: Tesla thrived with a government loan… Fisker Automotive, which also got a government loan, halted production last year. Getty Images¶ While opponents of clean energy hold up Solyndra LLC as proof of a problem, only about 2% of the Department of Energy's loan portfolio has defaulted. And while it's true that the government cannot discipline losers, the same is true for all lenders: Debtholders don't have equity, and so lack a management role.¶ Main Mission¶ **The government's main mission here is not to avoid losses. It is to help new companies and industries thrive. Businesses like BrightSource, Tesla and Project Amp, building a distributed rooftop solar project in 28 states plus the District of Columbia, needed government support because banks won't lend hundreds of millions of dollars to innovative technologies. Yet billions of dollars is what it takes to bring these technologies to market. And the government is uniquely able to provide this capital**.¶ Would some of these companies have been able to raise money without government help? Possibly, but the money almost certainly would have been unaffordable. Loans from the government are significantly cheaper than private-sector financing for innovative projects.¶ **Investing in clean energy is a government success story. Rather than debating whether to make more such investments, we should focus on moving more money through these programs.**

#### Any commercialization of offshore renewables requires usfg

OREC 13 (OREC, oceanic renewable energy coalition)August 1, 2013 “News Release: Marine Renewable Energy Legislation Introduced in Senate”

http://www.oceanrenewable.com/2013/08/01/news-release-marine-renewable-energy-legislation-introduced-senate/

“The Ocean Renewable Energy Coalition (OREC) strongly supports the Marine and Hydrokinetic Renewable Energy Act and is pleased that Senators Wyden and Murkowski were able to provide the bipartisan leadership for this effort,” said Sean O’Neill, OREC’s President. “The funding authorized in this measure, along with its regulatory efficiencies, demonstrates America’s intention to capture the emission free, predictable, and sustainable power in our oceans and free moving water currents,” said O’Neill. “The Wyden/Murkowski bill sends a clear message across the MHK supply chain that the federal government’s commitment to advance the technology and move it into the market is strong, serious and sustained.”¶ Commercialization of technologies to harness marine renewable energy resources will require federal funding to augment research and development efforts already underway in the private sector. Federal funding will leverage additional capital from the private sector to develop promising technologies that are on the verge of commercial viability.

#### Alternative energy companies get financed through the USFG which is critical to commercialization

Research Recap 10 (research recap is designed to showcase compelling industry, economic, academic, market, investment and credit research) Jun. 11, 2010 “U.S. Pushes for Advanced Biofuels Market Growth” http://seekingalpha.com/article/209654-u-s-pushes-for-advanced-biofuels-market-growth

The advanced biofuel market in the US is an evolving market attracting investors as well as policy makers. Major industry players such as BP (BP), Shell (RDS.A), Chevron (CVX), Abengoa (OTCPK:ABGOF) as well as technology-specific companies such as Codexis (CDXS), BlueFire (OTCPK:BFRE), Verenium (VRNM), OriginOil (OTCQB:OOIL) and Rentech (RTK) are investing in this industry for technological developments and the establishment of production facilities.¶ The industry is evolving fast due to technological innovations, large investments by private players, and support from the US government. The biofuel companies are focusing on developing advanced biofuel technologies aided by strong financing support through joint ventures, equity offering and venture financing.¶ Major biofuel investors in the US are Range Fuels, Inc., BlueFire Ethanol Fuels, Inc. and Mascoma Corporation. Since 2008, some of the key players in the US advanced biofuel industry have invested $1.4 billion to commercialize the technologies and develop the market.Advanced biofuels has also attracted the focus of oil majors.¶ US Department of Energy (DoE) has provided $718m in funding for the commercialization of advanced biofuels as well as to help the industry to meet the mandated production targets for advanced biofuels, which will increase from 950 million gallons in 2010 to 21 billion gallons per year in 2022.¶

### AT Not Economical/Cost Competitive

#### OMEGA will be cost-competitive – it has economic benefits beyond algae biofuels

Katie Howell, 5/12/2009, New York Times, “NASA bags algae, wastewater in bid for aviation fuel,” <http://www.nytimes.com/gwire/2009/05/12/12greenwire-nasa-bags-algae-wastewater-in-bid-for-aviation-12208.html>

"We don't think this would be cost-effective if we just go after the fuels," Trent said. "But we're functioning on at least three different levels: making the products -- fuel, fertilizers -- then wastewater processing and carbon sequestration. The economic model becomes more reasonable."¶ In fact, Trent said, the technology is nearly cost-competitive with land-based production methods for algae biofuels that require vast industrial-scale, open-air pond farms or in closed bioreactors.

#### An integrated, multiple purpose function makes the OMEGA model cost effective

Katie Howell, 5/12/2009, Scientific American, “NASA aims for future fuel from algae-filled bags of sewage,” <http://www.scientificamerican.com/article/nasa-fuel-algae-sewage/>

NASA's plastic bags are designed to last up to three years, Trent said. After that, they could be recycled as plastic mulch or chopped and used to improve soil quality and help retain moisture.¶ "We don't think this would be cost-effective if we just go after the fuels," Trent said. "But we're functioning on at least three different levels: making the products – fuel, fertilizers – then wastewater processing and carbon sequestration. The economic model becomes more reasonable."¶ In fact, Trent said, the technology is nearly cost-competitive with land-based production methods for algae biofuels that require vast industrial-scale, open-air pond farms or in closed bioreactors.

### AT Algae Biofuels Fail (Catch-22/Lipids/Carbohydrates)

#### Recent scientific breakthroughs can overcome the catch-22 problem with algae biofuels

Science Daily, 11/20/2013, “breakthrough for biofuel production from tiny marine algae,” <http://www.sciencedaily.com/releases/2013/11/131120192147.htm>

A significant roadblock in algae biofuel research surrounds the production of lipid oils, the fat molecules that store energy that can be produced for fuel. A catch-22 has stymied economically efficient biofuel production because algae mainly produce the desired lipid oils when they are starved for nutrients. Yet if they are limited in nutrients, they don't grow well. With a robust diet algae grow well, but they produce carbohydrates instead of the desired lipids for fuel.¶ In a significant leap forward that clears the lipid production hurdle, Trentacoste and her colleagues used a data set of genetic expression (called "transcriptomics" in laboratories) to target a specific enzyme inside a group of microscopic algae known as diatoms (Thalassiosira pseudonana). By metabolically engineering a "knock-down" of fat-reducing enzymes called lipases, the researchers were able to increase lipids without compromising growth. The genetically altered strains they developed, the researchers say, could be produced broadly in other species.

#### Marine algae is viable – research has overcome the catch-22 hurdle

John Daly, 11/25/2013, Oil Price.com, “research unlocks algae biofuel potential,” <http://oilprice.com/Alternative-Energy/Biofuels/Research-Unlocks-Algae-Biofuel-Potential.html>

Along with camelina and jatropha, marine algae is a front runner in the search for a renewable feedstock for production of commercial quantities of biofuel.¶ While marine algae produce lipid oils, fat molecules that store energy needed for fuel production, the process occurs when they are nutritionally starved, which also stunts their growth. When well-nourished, the algae do grow well, but produce carbohydrates instead of the desired lipids for conversion to fuel. But, in a breakthrough with potentially massive implications for production of commercial quantities of biofuel, researchers at the renowned Scripps Institution of Oceanography at the University of California, San Diego have developed a way to target a specific enzyme inside a group of microscopic algae known as diatoms, metabolically engineering a way to increase their production of lipids without hurting growth.

### AT Bolden Controversy

#### The Bolden controversy does not implicate OMEGA

Dunn 10 (Marcia, AP, “NASA Head Charles Bolden Mired In Controversy” Huffington Post, 9/20/10 http://www.huffingtonpost.com/2010/09/20/nasa-head-charles-bolden-\_n\_731885.html)//EAZYE

CAPE CANAVERAL, Fla. — NASA's chief found himself mired in another controversy Monday, this time for making "inappropriate" contact with an oil company while considering an alternative fuel project. The space agency's inspector general reported that a 10-minute phone conversation last April between Administrator Charles Bolden Jr. and a senior Marathon Oil Corp. official was inconsistent with the ethics pledge he signed upon taking office last year. It also raised concerns about an appearance of a conflict of interest, the inspector general said. Bolden – a two-time space shuttle commander and retired Marine general – is a former board member of Marathon and remains a major stockholder. At the time of the phone call in question, his stock was worth between $500,000 and $1 million. In an 11-page report, NASA Inspector General Paul Martin concluded that Bolden's contact with Marathon did not violate federal laws or ethics regulations. But the action unsettled some within NASA and was the latest in a series of embarrassing missteps by Bolden. The algae-based fuel research project, called Omega, is run by NASA's Ames Research Center in Mountain View, Calif. Bolden wanted the technical opinion of someone at Marathon, while he was considering a proposed agreement between NASA and the Navy, the inspector general said. The inspector general said Bolden pledged upon taking office in July 2009 to refrain for two years from having private communications with Marathon or any other of his former employers, regarding NASA business. One of those interviewed for the inspector general's report was the director of Ames, Simon "Pete" Worden. In an e-mail exchange in May with NASA deputy administrator Lori Garver, Worden wrote: "In the interest of open government and transparency, I think my folks are entitled to know who talked to Charlie and the basis of their criticism so we can respond." Worden continued: "This is frankly the worst of NASA and I don't like it. It is 'good ole boy' networks at its worst and not worthy of NASA and this Administration." Bolden said he readily accepts the inspector general's findings. "My intention was to gather an outside perspective about a potential agency research project," Bolden, 64, said in a statement issued by NASA on Monday. "I should have explored the implications of my inquiry prior to acting." The Omega project continues, Bolden noted, "and its future development will be decided solely on its technical merits." NASA has committed to funding the project for up to $10 million over the next two years.

### AT Picking Winners Bad

#### Picking winners is inevitable – that is key to bringing cleaner fuels online

Ken Silverstein, 12/6/2013, Forbes, “energy subsidies fan the flames but all sectors share in the federal pie,” <http://www.forbes.com/sites/kensilverstein/2013/12/06/energy-subsidies-fan-the-flames-but-all-sectors-share-in-the-federal-pie/>

The production tax credit given to the wind energy industry may run out of gas and not get renewed before year-end. But the subsidy is now fanning the flames on all government largess and specifically which industries are the most worthy of getting the added incentives.¶ Just how taxpayer money gets doled out is mired in so much intricacy that is difficult to follow. The United States will certainly expand its economy and as such, it will require newer and cleaner fuel sources, as well as the traditional fossil fuels that have met the preponderance of the country’s energy needs. The various fuels are, no doubt, competing for a limited share of the federal pie, which for better or worse, has always fed the American energy sector.¶ At issue right now is the 2.3 cent per kilowatt hour production tax credit awarded to wind developers. If they tee off this year but the construction continues into next, they still qualify — for 10 years. Altogether, according to the U.S. Energy Information Administration’s latest analysis is that about $37 billion got awarded to fuels of all stripes in 2010. It says that the wind sector received $4.2 billion of that from the stimulus plan enacted in 2009.¶ The wind energy sector is arguing that it is money well-spent. Wind-related components have grown from roughly a quarter of the nation’s manufacturing base to more than half of it, says the American Wind Energy Association. That is coming from 559 factories that have created 85,000 jobs.¶ Moreover, the trade group says that utilities are supplementing their electric generation with wind power because it is economical and because it can kick in when electricity is most needed. Power companies have signed agreements to buy 5,670 megawatts of new power this year while 2,300 megawatts are getting built. About 60,000 megawatts of wind power now exist.¶ American Electric AEP +0.06% Power has said that it has decided to triple its initial wind requests because of “extraordinary pricing opportunities” that will cut customers’ bills. Xcel Energy XEL +0.06%, meantime, is pitching its customers on the idea, saying that “wind energy can save you money” — and help it reduce carbon emissions.¶ Production costs are, indeed, falling fast. But this necessitates more federal help, not less, wind enthusiasts say. The Energy Information Agency does say that development would continue if the tax credits are extended.¶ While the wind association does not bash other fuel forms, some of its supporters often do and have gone after everything from major infrastructure projects such as they Keystone XL Pipeline to the shale gas drilling process to the pushing for tougher regulations on existing coal-fired power plants.¶ In the short run, renewables may have gotten more federal subsidies, they admit. But over the last decade, and longer, the fossil fuels have run up a tab that far exceeds that of the greener fuels, they add.¶ President Obama has publicly touted the elimination of tax breaks given to oil and gas developers that add up to $4 billion a year. Interestingly, conservative organizations such as the Heartland Institute and Taxpayers for Common Sense say that these federal payouts should be reconsidered.¶ “Government should generally steer clear of picking and choosing technologies for the market,” says Ken Green, with the free market-oriented Fraser Institute. “Government has a decent record (and legitimate role in) basic research and development, but it has a very bad track record at picking technologies that succeed. The only thing that can tell us what works best in energy markets are consumer choices made in a functioning, and minimally-distorted market.”¶ But the American Energy Alliance, which represents fossil fuel interests, counters that thinking by saying that oil, natural gas and coal power far more of the economy than green energy. For electric generation, coal and natural gas provide about 70 percent of the fuels while the renewable sector, including hydro, is around 10 percent — but it got 55 percent of the federal assistance.¶ Right now, the group’s target is the elimination of the production tax credit. In a letter to U.S. lawmakers, it references the U.S. Department of Energy and says that wind power had comprised 43 percent of all newly constructed generation in 2012. That’s more than natural gas and has come at a time when the demand for energy has been flat. It says that wind is straining the transmission grid and hampering reliability.¶ “The growth in wind is driven not by market demand, but by a combination of state renewable portfolio standards and a tax credit that is now more valuable than the price of the electricity that the plants actually generate,” says its letter.¶ The oil and gas companies add that they support 9.2 million jobs, which is the “biggest stimulus” that this country has going. ¶ Exelon EXC -0.39% Corp., which relies on nuclear energy, supports the American Energy Alliance’s position. It has said that wind energy requires huge subsidies that are encouraging its development while also hurting the ability of other fuels to fairly compete, distorting markets.¶ Determining who gets what is a subjective undertaking and the outcome depends largely on politics and philosophy. And while the United States government must watch what it spends, it has to continually invest in promising technologies — ideas that could increase energy independence in a cleaner fashion.

#### Government intervention is necessary to spur algae development – start-up costs are too high

**Times** June 5 **2008** “What's green, slimy and could save the Planet?”

**Algae farms could be the next big thing in energy creation - but we need huge investment to spur their growth**  Sorry, Africa, but I need your next meal to run my pick-up down to the mall. Just shove your corn in my tank, will you? This thing only does 20 miles to the gallon. Don't blame me, blame all those middle-class Indians and Chinese who want to live like us. They're the reason food prices are rising. What, you're hungry? Can't you call the UN? The moral dimensions to food and energy prices, and the links between them, are becoming inescapable. There is huge resentment about biofuels at this week's World Food Summit, even though prosperity is the main reason for higher food prices. There was outrage in India recently, when Condoleezza Rice appeared to blame its middle-class for costlier food. Why shouldn't we eat the same as you, asked Indian MPs. We're still thinner. And why should the West suck up prime agricultural land to grow subsidised biofuels just to keep driving cheaply? It's bad enough that a high oil price makes fertiliser and tractor fuel more expensive. It's utterly irresponsible to burn food to make fuel. The same blame game is being played with climate change. You've put more carbon dioxide into the atmosphere than we have, say the Chinese. Don't tell us to cool it. Britain, according to Jim Hansen of Nasa, has a greater stock of carbon dioxide on its conscience than any other country, since it industrialised first. You lot started the first industrial revolution, a Brazilian once raged to me. Why can't you start the second? Maybe we can. **While governments wrangle, entrepreneurs and scientists are in a race to reinvent energy, including biofuels**. Dot-com billionaires such as Vinod Khosla, of Sun Microsystems, and Paul Allen, of Microsoft, are ploughing their fortunes back into schemes that probably sound as crazy as Google once did. Giant mirrors are tracking the Sun in New Mexico, powered by microprocessors to concentrate the rays. Enzymes are breaking down the non-edible parts of plants to make fuel in Canada. Algae, that green stuff in your pond, is being used to make biodiesel in New Zealand. Algae can grow almost anywhere, even in deserts. And some species grow so fast that they double in size three or four times a day. According to Fred Krupp, author of the excellent Earth: The Sequel, it would take only 47 million acres of algae to produce fuel for half of America's cars, compared with 1.5 billion acres of soy beans. I never knew pondlife was so exciting. Algae also eat carbon dioxide at a similarly prolific rate. That makes them multitasking miracle-workers: both a fuel and a way to clean up power-plant emissions. Not surprisingly, **several companies are now trying to move from relatively small algae beds to industrial scale.**  Solar is another example where science and venture capital converge. Last year I spent a frustrating afternoon with physicists at Imperial College who patiently explained how to make thin films, fabrics, even paint, capable of cap-turing energy from sunlight. The technology was beyond me. But I did grasp the economics. Making thin films from synthetic materials will dramatically reduce the cost of solar technology. **There are still technical problems with many technologies.** With algae, it is how to harvest at scale. With solar, it is how to store the energy efficiently. But **the biggest challenge is no longer in the lab. It is lack of capital to get these ideas to scale.** Successful internet companies such as Google were launched with millions of dollars. But **building** solar power plants or **biofuel refineries requires hundreds of millions. That means investors taking much bigger risks, in a sector where profits are enormously influenced by government regulation**.  **What's the answer? You can subsidise particular industries**, as Japan and Germany have done with solar. But that means picking winners. Or you can put a price on carbon dioxide. That changes the way that companies compare the costs of building a dirty coal plant with, say, a clean solar one. The EU has already put a low price on carbon dioxide, which it is gradually ratcheting up. John Doerr, the legendary investor who first backed Google and Amazon, has said that a similar cap on carbon in America would make thin-film solar technology competitive with conventional electric-ity in only two years. Which is why historians may come to see Monday night as a turning point.

**Private companies alone aren’t enough to make algae viable in the short term—only government incentives solves**

**SNS** (States News Service) August 27 **2008** “Whether Brown Or Red, Algae Can Produce Plenty Of Green Fuel”

Having studied the physiology of algae for more than 30 years, Rose Ann Cattolico is convinced the plant life found in oceans and ponds can be a major source of environmentally friendly fuels for everything from cars and lawn mowers to jet airplanes.¶ She's not the only one. Recently Allied Minds, an investment company that works with universities to commercialize early-stage technology, invested in the University of Washington biology professor's work, forming a startup company called AXI. "People don't realize how many types of algae there are -- from single cells to large kelp -- and each one develops differently," Cattolico said. "What we're trying to do is choose the best of the best, the ones that produce the right lipids for a particular type of fuel." AXI won't be in the business of making fuel. Instead, it will work with biofuel producers to develop strains of algae that produce just the right lipids, or oils, for the fuel that the producer wants to make. The methods will not employ genetic modification, Cattolico said. "It's not like creating a widget. It's a dynamic process that will change all the time," she said. Unlike many agriculturally important crops such as corn that produce starch as a byproduct of photosynthesis, some algae make lipids. One type of algae might produce oil appropriate for a motor vehicle. Another might be useful for home heating oil. Yet another might produce lipids just right for powering an airliner across the Pacific Ocean. Some strains could produce oil useful for other products, such as the omega 3 fatty acids that make fish oil dietary supplements so popular. Algae grow rapidly and do not require the use of productive farmland. Algae also can use various nutritional sources, including wastewater, Cattolico said. A variety of factors made this an opportune time to form AXI, said Erick Rabins, the company's interim manager and vice president of Allied Minds, based in Quincy, Mass. Escalating costs for oil (from about $27 a barrel to more than $100 in five years), rising demand for alternative fuels, the effects of climate change, and growing concern about using foods such as corn and soybeans as fuel stock are making fuel from algae a much more attractive option. But that won't necessarily translate into rapid development of algae-based fuels, Rabins said. Entire infrastructures, from specialized growing facilities to processing plants, will have to be created, and that will come only after potential producers see the value and make the investment. He speculated that it could take 10 to 25 years before algae-based biofuel is readily available to the public, though specialty uses could appear sooner. "The most optimistic assessment that I've heard is that it could be six to eight years before there's something that's useable, but the tools and techniques to make it possible are being created right now," he said. Details of the agreement between Allied Minds and UW TechTransfer to commercialize Cattolico's synthesis methods were not disclosed. The company was drawn to her work, Rabins said, because she has spent so many years making detailed analyses of many different strains of algae, in essence creating a reference database. Cattolico began studying algae almost by accident. As a master's degree student she worked with terrestrial plant pollen. But it turned out she was allergic to pollen and her physician advised her to change fields, so for her doctoral work she began studying chlorophyll-containing structures within the cells of algae. That was in 1973, right at the end of another major societal spasm over fuel shortages and high gas prices. As gasoline became more plentiful again, demands for finding alternative fuel sources grew dimmer and "all of the money for research dried up," Cattolico said. **In the current fuel debate, Cattolico readily points to the merits of algae-based biofuel. But she believes it is only a part of the answer to high fuel prices and replacing current fuels with climate-friendlier alternatives. She would like to see a broad commitment by government** and industry **to quickly develop the alternate energy sources needed to reduce environmental problems, increase national security and hold down costs. "What we need is a Manhattan Project for fuel. If we can get a Manhattan Project for fuel, it won't take 25 years," Cattolico said.**

### FYI: How OMEGA Works

#### (Description of the OMEGA process)

<http://www.nytimes.com/gwire/2009/05/12/12greenwire-nasa-bags-algae-wastewater-in-bid-for-aviation-12208.html>

The process is amazingly simple. It starts with algae being placed in sewage-filled plastic bags, which in true NASA style have a nifty acronym, OMEGA, for "offshore membrane enclosures for growing algae."¶ The OMEGA bags are semipermeable membranes that NASA developed to recycle astronauts' wastewater on long space missions. In this case, the membranes let freshwater exit but prevent saltwater from moving in.¶ Then the algae in the bag feast on nutrients in the sewage. The plants clean up the water and produce lipids -- fat-soluble molecules -- that will be used later as fuel.¶ Just as in algae biofuel production on land, the floating OMEGA bags use water, solar energy and carbon dioxide -- which in this case is absorbed through the plastic membrane -- to produce sugar that algae metabolize into lipids.

## Corn Ethanol Scenario-Extensions

### Add-On Scenario: Honey Bees

#### Corn Ethanol leads to the mass death of honey bees

Woody June 12

June 12, 2014 By [Todd Woody](http://www.takepart.com/author/todd-woody) Why You Should Worry About America's Corn Addiction¶ The $65 billion crop is depleting aquifers, polluting the Gulf of Mexico, and contributing to climate change.¶ Todd Woody is TakePart's senior editor for environment and wildlife. http://www.takepart.com/article/2014/06/12/how-corn-contributing-climate-change-and-water-shortages

The U.S. Department of Agriculture estimates that the cost of removing agricultural nitrates from drinking water supplies has hit an estimated $4.8 billion annually, and in 2013 corn farmers lost $420 million in fertilizer that washed into the Mississippi River and eventually into the Gulf of Mexico.¶ “The ethanol sector also makes a significant contribution to water pollution through its corn purchases,” wrote Ceres researchers in the study. “This report identifies 60 corn ethanol refineries with $8.8 billion in annual production capacity that are sourcing corn from watersheds with high local nitrogen pollution from agriculture.”¶ Although the report did not address the issue, scientists believe the vast expansion of acreage devoted to a single crop like corn has contributed to the [mass die-off of honeybees, which pollinate a third of the world’s food supply](http://qz.com/133155/why-the-worlds-bees-are-dying-theyre-stressed-out/). That’s because so-called monoculture has eliminated wildflowers and other plants that bees depend on for food.¶ So what is to be done? The report recommends that growers adopt better fertilization practices and switch to drip irrigation and other water-efficient technologies. (A fifth of corn is still grown by flooding furrows.)¶ The report's best advice to corporate corn customers and investors, though, was this: “When possible, buy less corn.” That's also true for consumers, who can lessen the demand for corn by scrutinizing product labels and avoiding processed foods.

#### Human life is dependent on honey bees

Gibson June 1

BEES, BITES, & MONOCULTURE¶ [JUNE 1, 2014](http://danaleegibson.com/bees-bites-monoculture/) [DANA LEE GIBSON](http://danaleegibson.com/author/danalg/) http://danaleegibson.com/bees-bites-monoculture/

Monoculture is the agricultural practice of producing or growing a single crop or plant species over a wide area and for a large number of consecutive years. It is widely used in modern industrial agriculture and its implementation has allowed for large harvests from minimal labour. Agricultural monocultures can lead to the quicker spread of pests and diseases, where a uniform crop is susceptible to a pathogen. To put it simply, if every field of corn we grow is identical, when a pest or disease finds a vulnerability to that corn then every field of corn in the country could be devastated. Nature is constantly trying to “pick the lock” and as soon as it does that species is vulnerable. Nothing is static in nature, the world of bio-diversity is a constant struggle, a constant evolution of life. Agricultural monocultures do not naturally occur because they are extremely vulnerable.¶ In computer science, a monoculture is a community of computers that all run identical software. All the computer systems in the community thus have the same vulnerabilities, and, like agricultural monocultures, are subject to catastrophic failure in the event of a successful attack. This concept is significant when discussing computer security and viruses. In particular, Microsoft is a monoculture, since a majority of the overall number of workstations connected to the Internet are running versions of the Microsoft Windows operating system, many of which are vulnerable to the same attacks. But it is not limited to Microsoft. As Apple becomes a larger player in the market they too can become vulnerable. If the iOS become the dominant mobile operating system it is just as vulnerable as the Microsoft operating system. This is not to say that the iOS has the same vulnerabilities technically speaking. Rather, it has the potential of becoming a monoculture, which in itself comes with vulnerabilities.¶ We have engineered crops to be easy to plant, grow and harvest. We have changed life forms to better conform to our mechanized needs. This allowed for more automation and thus less effort for greater results. The side effect is a loss of knowledge, talent, and expertise. We become a people who only know when to turn on the irrigation systems and when to run the satellite navigated harvesting machines. The same can be said for the average person who’s job is centered around the personal computer. People only know what to click on but they have no idea why they are doing it. The technological advances have made it possible to do more with fewer people. The side effect is the same as in the agricultural field, a loss of knowledge, talent, and expertise.¶ Monocultures effect systems all around them. One of the suspected causes of CCD ([Colony Collapse Disorder](http://en.wikipedia.org/wiki/Colony_collapse_disorder)) is the forcing of a monoculture on the honey bee. For millions of years the honey bee has had a constantly changing and evolving diet. Today we force them to build their hives in specifically sized boxes designed for ease of mechanization. We pre-print the size of the honeycomb they build for better efficiency. We then force them into areas where the only source of food is a genetically modified monoculture of plants. All of which is wholly un-natural and without precedence in human history at the scale we are doing it today.¶ We have become dependent on our technology and the honey bee for our very existence. The honey bee is responsible for every third bite of food we eat. Most every business and industry is wholly, or partly dependent on a computer. Think about your job, what would your place of work do if it had no computers or internet. Could you function without them?¶ We must foster a deeper understanding of technology. We as a species, and as individuals need to drop our fear of technology. We should be fearful of a too large, too smooth computer monoculture. Our emphasis should not be on who is the biggest computer company or who is making the most money. The emphasis should be on how much variety and diversity is out there. Allowing lots of different types of systems to work together should be our goal and not converting every machine to the same system. We should follow the example in nature, constant change and growth.¶ We should not all be eating the same potato or using the same operating system.

### Food Insecurity Impact – World War

#### World War III results as countries use weapons to fight for food

Calvin 1998 (William H.; Professor of Psychiatry and Behavioral Sciences – University of Washington) January "The Great Climate Flip-Flop" Atlantic Monthly 281:1 EBSCO

The population-crash scenario is surely the most appalling. Plummeting crop yields would cause some powerful countries to try to take over their neighbors or distant lands – if only because their armies, unpaid and lacking food, would go marauding, both at home and across the borders. The better-organized countries would attempt to use their armies, before they fell apart entirely, to take over countries with significant remaining resources, driving out or starving their inhabitants if not using modern weapons to accomplish the same end: eliminating competitors for the remaining food. This would be a worldwide problem – and could lead to a Third World War – but Europe's vulnerability is particularly easy to analyze. The last abrupt cooling, the Younger Dryas, drastically altered Europe's climate as far east as Ukraine. Present-day Europe has more than 650 million people. It has excellent soils, and largely grows its own food. It could no longer do so if it lost the extra warming from the North Atlantic.

#### Food insecurity causes global instability, war, and billions of deaths, threatening extinction.

Winnail, Ph.D., M.P.H, FROM THE WORLD AHEAD, September-October 1996, http://www.kurtsaxon.com/foods004.htm

As a result grain prices are the highest on record. Worldwatch Institute's president, Lester Brown, writes, "No other economic indicator is more politically sensitive that rising food prices...**. Food prices spiraling out of control could trigger not only economic instability but widespread political upheavals"-- even wars.** The chaotic weather conditions we have been experiencing appear to be related to global warming caused by the release of pollutants into the earth's atmosphere. A recent article entitled "Heading for Apocalypse?" suggests the effects of global warming--and its side effects of increasingly severe droughts, floods and storms--could be catastrophic, especially for agriculture. The unpredictable shifts in temperature and rainfall will pose an increased risk of hunger and famine for many of the world's poor. With world food stores dwindling, grain production leveling off and a string of bad harvests around the world, the next couple of years will be critical. Agricultural experts suggest it will take two bumper crops in a row to bring supplies back up to normal. However, poor harvests in 1996 and 1997 **could create severe food shortages and push millions over the edge.** Is it possible we are only one or two harvests away from a global disaster? Is there any significance to what is happening today? Where is it all leading? What does the future hold? The clear implication is that things will get worse before they get better. **Wars, famine and disease will affect the lives of billions of people!** Although famines have occurred at various times in the past, **the new famines will happen during a time of unprecedented global stress**--times that have no parallel in recorded history--**at a time when the total destruction of humanity would be possible!** Is it merely a coincidence that we are seeing a growing menace of famine on a global scale at a time when the world is facing the threat of a resurgence of new and old epidemic diseases, and the demands of an exploding population? These are pushing the world's resources to its limits! **The world has never before faced such an ominous series of potential global crises at the same time!** However, droughts and shrinking grain stores are not the only threats to world food supplies. According to the U.N.'s studies, all 17 major fishing areas in the world have either reached or exceeded their natural limits. In fact, nine of these areas are in serious decline. The realization that we may be facing a shortage of food from both oceanic and land-based sources is a troubling one . It's troubling because seafood--the world's leading source of animal protein--could be depleted quite rapidly. In the early 1970s, the Peruvian anchovy catch--the largest in the world--collapsed from 12 million tons to 2 million in just three years from overfishing. If this happens on a global scale, we will be in deep trouble. This precarious situation is also without historical precedent!

### Food Prices – AT Alt Causes

#### Corn ethanol is the most important driver of high food prices – outweighs other alt causes

Alyssa Carducci, 1/28/2013, Heartland, “study: ethanol mandates causing spiraling US food prices,” <http://news.heartland.org/newspaper-article/2013/01/28/study-ethanol-mandates-causing-spiraling-us-food-prices>

For more than half a century, from 1950 through 2005, U.S. consumers benefited from gradually declining food prices. Since 2006, however, prices have sharply risen, with a typical family of four now paying $2,055 more in food bills than would be the case if costs had kept to the 1950-2005 trend line.¶ Rapidly rising corn prices, caused primarily by ethanol subsidies and mandates, are the most important factor in rising food prices.¶ “Fuel ethanol production capacity, based almost entirely on corn as a feedstock, exploded from 2006 to 2009,” the study reported. “Demand for corn to supply the new plants also exploded. Corn production did not keep up with the higher demand, and corn prices have more than tripled since the mandates came into effect.”¶ “Corn is just one of many basic farm inputs used to produce the U.S. food supply. However, with increases in biofuel demand and declining corn production, corn prices have increased sharply. In turn prices of other major crops have also gone up significantly. This ranges from major field crops like soybeans and wheat, to horticultural crops such as potatoes, strawberries, and processing vegetable crops. Higher prices for other crops were necessary in order for those crops to compete with corn for land.… These higher commodity prices mean higher incomes for crop producing farmers, but also higher food production costs, higher consumer food prices, and increased food costs for family budgets,” the study explained.

### UQ – Corn Ethanol Production High

#### Corn ethanol production remains high

AgriMoney, June 2014, “US ethanol output hits record, lifting corn price,” <http://www.agrimoney.com/news/us-ethanol-output-hits-record-lifting-corn-price--7174.html>

US ethanol production soared to a record high as plants prepared for rising seasonal demand against a background of positive margins, supported by weak corn prices and rising crude oil values.¶ US biofuel plants produced an average of 972,000 barrels a day of ethanol last week, up 28,000 barrels a day on the previous week, and the highest figure since records began four years ago.¶ Some increase had been expected, given the weak markets in corn - the main raw material for US ethanol producer - and strength in gasoline prices, up more than 6% in the past two weeks, buoyed by the latest round of Middle East unrest which has underpinned energy market overall.

### Solvency - Displace Corn Ethanol

#### Algae biofuels can displace current biofuels

Trent 6/20

(http://thegreentoolkit.wordpress.com/2014/06/20/nasas-plan-to-turn-water-pollution-into-biofuels-using-algae/ June 20, 2014 The Green Toolkit¶ Charting Pathways to Regenerative Abundance, Date Accessed: 6.22.14)//BSpencer

**Lastly, biofuels grown on land have pushed out crops grown for food , and also incited land grabs by foreign conglomerates in parts of the developing world**. Growing **algae offshore transcends these issues, while significantly outcompeting other sources of biofuel** on the basis of yield.¶ ¶ **NASA’s OMEGA Project aims to transform a problem-nutrient pollution in coastal waters from cities and farms-and turn into a clean, high-yielding source of liquid fuel, improving local air and water quality while drawing down greenhouse gases.**

#### Commercialized algae biofuels will replace traditional biofuels

Tracey Schlematic, 2/26/2013, Thomas Net, “biofuel from algae part two: the way forward,” <http://news.thomasnet.com/IMT/2013/02/26/biofuel-from-algae-part-two-the-way-forward/>

The U.S. Department of Energy [DOE] has its sights set on algae biofuel, and the agency recently parted with a $15 million grant to establish an algae biofuel test bed in Arizona. NASA has also launched an algae biofuel initiative with an eye to long-distance space travel: imagine a spacecraft that can actually grow and refine its own fuel during the mission using wastewater. As the space agency sets its sights to an eventual manned mission to Mars, the technology is compelling.¶ While algae-based biofuel may not yet be out of the “Valley of Death,” the chances that it will reach commercial viability are greater every day. The process, once perfected, could ultimately put most other biofuels out of business.

### Corn Ethanol Bad – Warming

#### Corn Biofuels Don’t Meet Domestic Environmental Standards

Cappiello 14 (Dina Cappiello. AP Energy Writer. “Study: Fuels from corn waste worse than gas” *USA Today*. April 20, 2014.)

**Biofuels made from the leftovers of harvested corn plants are worse than gasoline for global warming** in the short term, a study shows, challenging the Obama administration's conclusions that they are a much cleaner oil alternative and will help fight climate change. A $500,000 study paid for by the federal government and released Sunday in the peer-reviewed **journal Nature Climate Change concludes that biofuels made with corn residue release 7% more greenhouse gases** in the early years **compared with conventional gasoline**. While biofuels are better in the long run**, the study says they won't meet a standard set in a 2007 energy law to qualify as renewable fuel**. The conclusions deal a blow to what are known as cellulosic biofuels, which have received more than $1 billion in federal support but have struggled to meet volume targets mandated by law. **About half of the initial market in cellulosics is expected to be derived from corn residue.**

#### Corn Ethanol Increases GHG Emissions

Yang et. al. 12 (Yi Yang, Junghan Bae, Junbeum Kim, and Sangwon Suh.  Department of Bioproducts and Biosystems Engineering. American Chemical Society. “Replacing Gasoline with Corn Ethanol Results in Significant Environmental Problem-Shifting”)JC

Previous studies on the life-cycle environmental impacts of corn ethanol and gasoline focused almost exclusively on energy balance and greenhouse gas (GHG) emissions and largely overlooked the influence of regional differences in agricultural practices. This study compares the environmental impact of gasoline and E85 taking into consideration 12 different environmental impacts and regional differences among 19 **corn**-growing states. Results show that E85 does not outperform gasoline when a wide spectrum of impacts is considered. If the impacts are aggregated using weights developed by the National Institute of Standards and Technology (NIST), overall, **E85 generates approximately 6% to 108% (23% on average) greater impact compared with gasoline**, depending on where corn is produced, primarily because corn production induces significant eutrophication impacts and requires intensive irrigation. If GHG emissions from the indirect land use changes are considered**, the differences increase to between 16% and 118% (33% on average**). Our study indicates that **replacing gasoline with corn ethanol may only result in shifting the net environmental impacts primarily toward increased eutrophication and greater water scarcity**. These results suggest that the environmental criteria used in the Energy Independence and Security Act (EISA) be re-evaluated to include additional categories of environmental impact beyond GHG emissions.

### AT Land Use Turn

#### Our method of algae farming doesn’t require land use

[Schelmetic](http://news.thomasnet.com/author/tschelmetic/), 13

(Tracey Schelmetic, A contributor to ThomasNet since 2010, Tracey writes about manufacturing, green technology, and other industrial topics for Industry Market Trends (IMT), Thomasnet News, “Biofuel from Algae Part One: The Pros and Cons of Pond Scum,” February 19, 2013, <http://news.thomasnet.com/IMT/2013/02/19/biofuel-from-algae-part-one-the-pros-and-cons-of-pond-scum/>)

One of algae’s major attractions is that unlike corn for ethanol or soybeans for biodiesel, algae can be grown in places unsuitable for food cultivation, which takes away the wasted space drawback by making use of non-arable, nutrient-poor land that won’t support conventional agriculture. Algae can be grown in ponds, tubes or even large bags provided it gets the right combination of vitamins, minerals and sunlight. It doesn’t require soil or even fresh water to grow, and when cultivated in large quantities, algae can produce more energy per acre than any land crop, making it the most energy efficient plant for biodiesel production: far more efficient than corn, sugar cane, or soy. And unlike row crops, which are dependent on growing seasons, algae can be grown at any time of year, since ideal growing conditions can be easily simulated. In addition, it requires no fresh water for irrigation and no application of petroleum-based fertilizers. Algae can thrive in desert ponds using high-saline water from aquifers that can’t be used for traditional crops. Many species of algae can even grow in wastewater from treatment plants and water that contains nitrates, phosphates, and other pollutants. In fact, algae ponds and cultivation facilities are often located as close as possible to wastewater or pollution sources, since algae thrives on both carbon and bacteria. Like most other biodiesels, algae is also essentially carbon-neutral. While it does emit carbon while it’s burned, it absorbs carbon as food during its growing cycle (like all plants), which means that its net carbon figure is zero. Algae is estimated to have a greenhouse gas footprint that is 93 percent less than conventional, petroleum-based diesel.

## Warming Scenario-Extensions

### Solvency – U.S. Transportation Sector key

#### The transportation sector in the US is a massive contributor to global warming – reducing petroleum demands is key

Shahan 10 August 9, 2010 By Zachary Shahan. Shahan has a B.A. in enviormental studies and a masters in city and regional planning. He is the editor of cleantechinica.com “Cars Cause Global Warming More than Planes, Study Finds”

<http://cleantechnica.com/2010/08/09/cars-cause-global-warming-more-than-planes-study-finds/>

ek

It is rather well-known now that transportation is one of the leading causes of global warming pollution in the world, and especially in the United States. NASA actually reported in February that motor vehicles are the largest net contributor to global warming pollution. Now, a new scientific finding in the journal Environmental Science & Technology shows that, counter to what most of us believe, driving a car causes more global warming pollution than flying the same distance in a plane. The study, “Specific Climate Impact of Passenger and Freight Transport,” finds that, in the short run, planes cause more global warming because they create more short-lived warming processes at high altitudes. However, when you take ‘everything’ — long- and short-lived gases, aerosols and cloud effects from transportation around the world — into account, an average car trip increases global temperatures more than an average flight the same distance. Furthermore, passenger trains and buses cause even four to five times less global warming pollution than automobiles per passenger mile. Of course, there are a lot of intricacies (i.e. the specific car or plane or bus used), but this is the general finding. “As planes fly at high altitudes, their impact on ozone and clouds is disproportionately high, though short lived. Although the exact magnitude is uncertain, the net effect is a strong, short-term, temperature increase,” lead author of the study, Dr. Jens Borken-Kleefeld, said. “Car travel emits more carbon dioxide than air travel per passenger mile. As carbon dioxide remains in the atmosphere longer than the other gases, cars have a more harmful impact on climate change in the long term.”

### Solvency – Biofuels Solve Warming

#### Biofuels solve transportation emissions and fuel dependency

IEA 11

(International Energy Agency, 20 April 2011, “Biofuels can provide up to 27% of world transportation fuel by 2050, IEA report says - IEA ‘roadmap’ shows how biofuel production can be expanded in a sustainable way, and identifies needed technologies and policy actions”, <http://www.iea.org/newsroomandevents/pressreleases/2011/april/name,20302,en.html>)

The International Energy Agency (IEA) is an autonomous organisation which works to ensure reliable, affordable and clean energy for its 28 member countries and beyond. Founded in response to the 1973/4 oil crisis, the IEA’s initial role was to help countries co-ordinate a collective response to major disruptions in oil supply through the release of emergency oil stocks to the markets. While this continues to be a key aspect of its work, the IEA has evolved and expanded. It is at the heart of global dialogue on energy, providing reliable and unbiased research, statistics, analysis and recommendations.

With the transportation sector growing considerably, and demand for transport fuels rising globally, the IEA assesses biofuels – liquid and gaseous fuels derived from biomass (organic material derived from plants and animals) – as one of the key technologies to reduce CO2 emissions and reduce dependency on liquid transport fuels. The report shows how global biofuel consumption can increase in a sustainable way – one in which production of biofuels brings significant life cycle environmental benefits and does not compromise food security – from 55 million tonnes of oil equivalent (Mtoe) today to 750 Mtoe in 2050; this would mean that the global share of biofuel in total transport fuel would grow from 2% today to 27% in 2050. “While vehicle efficiency will be the most important and most cost-efficient way to reduce transport-emissions, biofuels will still be needed to provide low-carbon fuel alternatives for planes, marine vessels and other heavy transport modes, and will eventually provide one fifth (2.1 gigatonnes of CO2) of emission reductions in the transport sector,” Bo Diczfalusy, the IEA’s Director of Sustainable Energy Policy and Technology, said at the launch of the report today in Washington. The IEA prepared the Technology Roadmap Biofuels for Transport in consultation with representatives of government, industry, academia and non-governmental organizations. The roadmap provides an overview of the current status of different conventional and advanced biofuel technologies and the latest research on sustainability issues related to biofuel production. It also charts a course for expanding the production and use of biofuels to 2050, in a sustainable way. This report is the latest in the IEAs series of technology roadmaps, which aim to guide governments and industry on the actions and milestones needed to achieve the potential for a full range of clean energy technologies. Efficient technologies needed Biofuels can provide transport fuel with substantially lower CO2 emissions than conventional gasoline or diesel when comparing the entire “life cycle” of production – that is, from the field to the vehicle. But there are caveats: it is important to reduce the use of fossil energy during cultivation, transport and conversion of biomass to biofuel. It is also important to avoid direct or indirect land-use changes, such as converting forests to grow biofuel feedstocks, which release large amounts CO2 and could offset the CO2 reduction potential of biofuels. Most conventional biofuels (produced mainly from starch, sugar and oilseed crops) must therefore be improved in terms of conversion- and land-use efficiency to achieve considerable greenhouse-gas reductions. In addition, advanced biofuel technologies currently at the demonstration stage (produced mainly from lignocellulosic biomass such as wood and straw), need to be commercially deployed within the next ten years and will provide the major share of biofuels in 2050. “Further support for advanced biofuel research, development and demonstration is still needed to improve conversion efficiencies and reduce costs. In addition, investments in commercial-scale production units will be a key to enable advanced biofuels to reach full market maturity,” said Mr. Diczfalusy at the launch in Washington. “Government action is needed to provide a stable, long-term policy framework for biofuels that allows for sustained investments in biofuel expansion. Specific support measures that address the high investment risk currently associated with pre-commercial advanced biofuel technologies will be vital to trigger industry investments in first commercial plants.” With these substantial investments in place, most biofuel technologies could get close to cost-competitiveness with fossil fuels, or even be produced at lower costs in the longer term. In total, the report assesses the expenditure on biofuels required to meet the roadmap targets between USD 11 trillion to USD 13 trillion over the next 40 years, depending on the actual production costs. “This figure may seem large, but in fact even in the worst case biofuels would only increase the total costs of transport fuels by around 1% over the next 40 years, and could in fact lead to cost reductions over the same period.”

#### Transportation contributes to GHG emissions-solved by biofuel

EPA 14

(Environmental Protection Agency, 4/17/2014, “Sources of Greenhouse Gas Emissions”, http://www.epa.gov/climatechange/ghgemissions/sources/transportation.html)

In 2012, greenhouse gas emissions from transportation accounted for about 28% of total U.S. greenhouse gas emissions, making it the second largest contributor of U.S. greenhouse gas emissions after the Electricity sector. Greenhouse gas emissions from transportation have increased by about 18% since 1990. This historical increase is largely due to increased demand for travel and the limited gains in fuel efficiency across the U.S. vehicle fleet. The number of vehicle miles traveled by passenger cars and light-duty trucks increased 35% from 1990 to 2012. The increase in travel miles is attributed to several factors, including population growth, economic growth, urban sprawl, and low fuel prices during the beginning of this period. Between 1990 and 2004, average fuel economy among new vehicles sold annually declined, as sales of light-duty trucks increased. However, new vehicle fuel economy began to improve in 2005, largely due to a lower light-duty truck market share and higher fuel economy standards. There are a variety of opportunities to reduce greenhouse gas emissions associated with transportation. The table shown below categorizes these opportunities and provides examples. For a more comprehensive list, see Chapter 5 of the Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change . Using fuels that emit less CO2 than fuels currently being used. Alternative sources can include biofuels; hydrogen; electricity from renewable sources, such as wind and solar; or fossil fuels that are less CO2-intensive than the fuels that they replace.

### Algae Biofuels - Carbon Neutral/Replace Fossil Fuels

#### Algae biofuels are carbon-neutral and can replace fossil fuels

Melinda Wenner, 5/1/2009, Scientific American, “the next generation of biofuels,” <http://www.scientificamerican.com/article/the-next-generation-of-biofuels/?print=true>

Americans burn through 140 billion gallons of gasoline a year. And even if drivers switch to more fuel-efficient cars and trucks, the nation’s fuel needs are expected to increase by a fifth over the next 20 years, thanks to dramatic increases in car and airplane use. Which is why, in addition to developing solar, wind and geothermal energy, policy makers, including President Barack Obama, are advocating biofuels to transform the transportation culture.¶ They’re not talking about ethanol from corn, however, which has already proved wasteful and environmentally damaging. Instead eyes are on a handful of high-tech labs around the U.S. that are perfecting ways to make the equivalent of gasoline and diesel from the lowest life-forms on the totem pole: yeast, algae and bacteria. The challenge is to make enough of these fuels economically and in a form compatible with today’s vehicles.¶ Once the next generation of biofuels becomes available, you could swing by the local energy station and fill up on a liquid that is virtually identical to gasoline. It would be made by U.S. companies, not shipped from the Middle East. And even though biofuels release carbon dioxide when they are burned, the organisms they are made from draw an equivalent amount of carbon dioxide from the air—making biofuels essentially carbon-neutral.¶ Going beyond Corn¶ Gasoline is refined from crude oil. Do-it-yourselfers who don’t want to depend on the oil companies have gone to elaborate lengths to run their old cars on biofuels, often by processing used vegetable oil salvaged from restaurant deep fryers and storing the result in a tank in the garage. On a commercial scale, however, today’s main biofuel is ethanol, also known as grain alcohol. It is made by fermenting corn kernels—a biological process similar to the one that gives us beer and wine. Put corn and yeast together in a big vat, and the yeast eats sugars in the corn, producing ethanol and water. Today more than 40 percent of the gasoline sold in the U.S. contains ethanol—typically premixed with gasoline to make a blend called E10 that is 90 percent gasoline, 10 percent ethanol. In a few areas, primarily the Midwest, a blend that is 85 percent ethanol (E85) is also sold for use in vehicles that have so-called flex-fuel engines.¶ Corn has been the raw material of choice because fermentation is a proved process and because of government subsidies. The agriculture industry, which is strongly wed to ethanol, has been able to convince the government to back its interests. But most scientists agree that the ethanol experiment hasn’t gone very well. According to a study published by Cornell University scientist David Pimentel, 21 pounds of corn are needed to produce just one gallon of ethanol. And farming that corn requires half a gallon of fossil fuels.¶ So not only could the production of corn-based fuels lead to food shortages, experts say, but the process is too inefficient to make a significant dent in our energy needs anyway. “When you look at what our ethanol production is and compare that against what our demand for transportation fuels is, we won’t get there,” says Virginia Lacy, a biofuels consultant at the Rocky Mountain Institute, a nonprofit energy policy organization in Colorado.¶ Most researchers agree that it’s time to dump corn-based ethanol, but they have two opposing theories about how to proceed. Jay Keasling, a chemical engineer at the University of California, Berkeley, is one of several investigators trying to make ethanol and related fuels from plants such as switchgrass, which grows quickly and resists many pests and diseases. His biggest challenge is getting yeast and other experimental microbes to digest all of the plant, including the stalks, which are tough to break down. Another sticking point for Keasling’s method is that plants require lots of space, not to mention time, to grow: our demand for plant-based fuels could surpass our ability to produce them.¶ That is why a second group of scientists—including J. Craig Venter, the entrepreneur and biologist whose Institute for Genomic Research in Rockville, Md., played a key role in mapping the human genome—argues for a bolder approach. These researchers believe that the best biofuels will bypass crop plants—cutting out the middleman entirely—relying instead on algae and a few microorganisms that have a plantlike knack for directly and efficiently turning sunlight into energy through photosynthesis. The scheme has yet to be proved on a large scale, however. “I haven’t seen anyone really do a fair calculation of what algae can do,” Keasling notes, “and until I see that, I’m not convinced.”¶ Regardless of the method, scientists will have to improve on Mother Nature to make a successful biofuel, tinkering with existing microorganisms or even building brand-new ones. Dozens of start-ups are manufacturing fuels from novel strains of yeast, algae and bacteria. Several promise that by 2011 they’ll have made gasoline or diesel substitutes that can be pumped directly into cars. And although these biofuels will probably first be supplied preblended with traditional gasoline or diesel—much the way E10 is today—one day we may use them alone and say good-bye to petroleum-based gasoline forever.

#### Algae biofuels can replace fossil fuels and are carbon neutral

Inside Business, 6/28/2013, “some think algae biofuel is the next big thing,” <http://insidebiz.com/news/some-think-algae-biofuel-next-big-thing>

But a new generation of biofuels based on algae might just change all that. One of the major problems with biofuels that algae could solve is space, since algae can yield as much as 100 times more fuel per unit area than other so-called "second generation" biofuel crops (e.g. non-food crops or non-food waste parts of food crops). Federal researchers from the U.S. Department of Energy report that it would take only 15,000 square miles - less than 1/7 the area now used to harvest all the corn across the country - to produce enough algae fuel to replace all of our petroleum fuel.¶ While burning algae-derived fuel in an engine or factory generates carbon dioxide emissions just like fossil fuels do, the algae itself requires carbon dioxide to photosynthesize - so overall no new carbon dioxide is added to the atmosphere. Furthermore, any carbon dioxide created through processing or refinement can be captured and redirected to the growing algae beds. And unlike other biofuel feedstocks, algae production has minimal impact on freshwater supplies - especially when it can be undertaken in ocean waters or even wastewater.

### Algae Biofuels - Sequestration extension

#### Algae farms will sequester C02 out of the atmosphere

Nagaich 14

Maximum-CO2 Tolerance in Microalgae: Possible Mechanisms and Higher lipid ¶ Accumulation ¶ ¶ Vaibhav Nagaich\*¶ ,¶ ¶ Sumeet Kumar Dongre, Pushpendra Singh, ¶ Mahavir Yadav, Archana Tiwari ¶ School of Biotechnology, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, Madhya Pradesh, Airport Bypass ¶ Road, Bhopal - 462033 India

We are still some way from realizing the absolute potential offered by algal biodiesel. For the purpose of CO2 ¶ sequestration, the use of microalgae is an exclusive technology. Life-cycle analyses suggest that using current ¶ methodologies the procedure is trivial in terms of positive energy balance and global warming potential. The actual ¶ process of photosynthesis, which can be utilized to fix carbon dioxide and produce useful by-products in a ¶ sustainable fashion, has been explained to be feasible and the design of a solar energized photo-bioreactor system ¶ for the function of carbon dioxide fixation was illustrated to be technically possible. CO2 mitigation and biofuels ¶ production could be mutual in an economically feasible and environmentally sustainable approach. The possibility ¶ of this strategy could be further improved by fixing CO2 from industrial exhaust gases such as flue gases and by ¶ integrating microalgal cultivation. To conclude, microalgae can securely be termed as the favorable system for CO2 sequestration compared to forests ¶ and other vegetation. These should be chosen over others due to their possible of faster growth, high photosynthetic ¶ efficiency, environment friendly operation of effluent nutrients and flue gas, and providing a spectrum of value ¶ added mercantile products with no waste by-products. Continued progress of technologies to optimize the ¶ microalgae production, wastewater treatment, and biomass processing has the facility to make important ¶ contributions towards this object.

### Warming – Real/Human Caused

#### Warming real - consensus

Brooks 12 - Staff writer, KQED news (Jon, staff writer, KQED news, citing Craig Miller, environmental scientist, 5/3/12, "Is Climate Change Real? For the Thousandth Time, Yes," KQED News, <http://blogs.kqed.org/newsfix/2012/05/03/is-climate-change-real-for-the-thousandth-time-yes/>)

BROOKS: So what are the organizations that say climate change is real? MILLER: Virtually ever major, credible scientific organization in the world. It’s not just the UN’s Intergovernmental Panel on Climate Change. Organizations like the National Academy of Sciences, the American Geophysical Union, the American Association for the Advancement of Science. And that's echoed in most countries around the world. All of the most credible, most prestigious scientific organizations accept the fundamental findings of the IPCC. The last comprehensive report from the IPCC, based on research, came out in 2007. And at that time, they said in this report, which is known as AR-4, that there is "very high confidence" that the net effect of human activities since 1750 has been one of warming. Scientists are very careful, unusually careful, about how they put things. But then they say "very likely," or "very high confidence," they’re talking 90%. BROOKS: So it’s not 100%? MILLER: In the realm of science; there’s virtually never 100% certainty about anything. You know, as someone once pointed out, gravity is a theory. BROOKS: Gravity is testable, though... Virtually every major credible scientific organization in the world says climate change is real. MILLER: You're right. You can’t drop a couple of balls off of the Leaning Tower of Pisa to prove climate change. That’s why we have to rely on mathematical models to try to figure out where this is all going. And that's difficult. But it’s not impossible, as some people like to paint it. You know, the people doing the models are not inept. Over the past nearly four years, Climate Watch has interviewed a lot of scientists, attended conferences, read academic papers. To me, as what you might call an informed observer, the vast preponderance of scientific evidence supports this notion that the Earth is warming and that human activity is a significant cause. BROOKS: Are there legitimate debunkers of this proposition? MILLER: Certainly there are legitimate scientists on the other side of the question. If you take, for example, a guy by the name of John Christy from the University of Alabama, who is very strongly identified with climate change skeptics. That doesn’t mean that his work is invalidated. He came out recently with a study that basically refuted the idea that there’s been an observable shrinkage in the snow pack of the Sierra Nevada. And we talked to other scientists who do believe in anthropogenic or human-induced global warming and do believe that the Sierra snow pack is going to be shrinking, who thought that this study was sound. But that’s one study in a sea of studies. And you have look at the preponderance of the evidence and not at any one particular study, not any particular year, not even any particular ten years, because even a 10-year trend does not necessarily constitute climate change. BROOKS: What are some of the metrics scientists have looked at to come to the conclusion that human-caused climate change is real? MILLER: They study temperature records. There have been tidal gauges in place for a long time, looking at sea-level rise, and also augmented now by satellite data that measure with greater accuracy the rate of the rise. They’ve looked at things like ice cores from Greenland and elsewhere which gives us sort of a reverse chronological story of what the climate has done. And you can actually pull one of those ice cores and see the amount of C02 that was in the atmosphere at the time. And what they've found is what looks to be a pretty convincing relationship between the amount of carbon dioxide in the atmosphere and the behavior of the Earth’s climate. BROOKS: But there are some who refute that evidence? MILLER: Absolutely. We’ll get people frequently commenting on our blog who will say the sea level is not rising and that there’s been no warming for the past ten years. As I already pointed out, ten years of anything does not constitute a definitive pattern; it’s just too short a time span. It’s this idea of cherry-picking data, which both sides accuse the other of doing. You have to look at the Earth’s climate over time as a really big, complicated jigsaw puzzle. And clearly there are pieces missing. And there are pieces sitting off to the side that aren’t missing, but we don’t quite know how they fit into the puzzle yet. But still, you see enough of the picture to know what’s going on. The science has yielded at least -- as Stanford's Chris Field of the IPCC puts it -- a blurry picture of the future. And the blurry picture is enough to know the general direction we’re heading, even without knowing all of the specifics. BROOKS: Are there former critics who now acknowledge the reality of climate change? MILLER: Richard Muller would be a good example of that. He’s the physicist over at UC Berkeley who was identified with the skeptic camp for a long time. He wasn’t buying a lot of climate change theory. He launched a temperature-data audit because he wasn’t convinced that the temperature data being used by the IPCC and NOAA and others was accurate, that there were fundamental issues – they were getting bad data, garbage in, garbage out.

#### Warming is anthropogenic Wood ‘10 – Duncan Wood is Full Professor, Director of the Program in International Relations (Duncan, “Environment, Development and Growth: U.S.-Mexico Cooperation in Renewable Energies“, 7/1/2013, http://www.statealliancepartnership.org/resources\_files/USMexico\_Cooperation\_Renewable\_Energies.pdf

The urgency of finding alternatives to fossil fuels has been confirmed in recent years by mounting scientific evidence that we are undergoing a noticeable anthropogenic shift in the world’s weather and temperature. Not only are a range of indicators showing that the planet is warming, but the retreat of the polar ice caps, the melting of glaciers, and most importantly in the short term extreme weather conditions and increased incidence of natural disasters have highlighted the consequences of maintaining the status quo in our patterns of energy consumption and industrial development. It is estimated that we have experienced a 1 degree Celsius rise in global temperatures over the past 100 years and that by the end of the current century global temperatures may have risen by as much 7 or 8 degrees. Even with the reduction in greenhouse gas emissions that is contemplated by the most ambitious mitigation strategies, global temperatures may raise by as much as 6%. This would have a dramatic and disastrous impact on both developed and developing nations and will threaten the existence of both humans and animal and plant species. Though the connection between man‐made greenhouse gases and global warming was denied for many years by industry and governments alike, it has now been accepted that something must be done to reduce the amount of greenhouse gases released into the atmosphere. Given that 86% of all global energy comes from fossil fuels, and that these fossil fuels produce 27,000,000,000 tons of CO2 emissions annually, finding alternative sources of energy is a crucial component of climate change mitigation strategies.

### Warming – AT Adaptation

#### Adaptation isn’t sufficient – reducing emissions key

Center for Climate and Energy Solutions, recently named the world’s top environmental think tank, 2011

(June 2011, Center for Climate and Energy Solutions, “Science FAQs,” http://www.c2es.org/global-warming-basics/faq\_s/glance\_faq\_science.cfm, accessed 7/12/13,

However, different regions and sectors will differ in their ability to adapt. Natural ecosystems have inherent, but limited capability to adapt to climate change, which is further impeded by other human impacts to the environment such as development and habitat fragmentation. Even human societies, particularly developing countries, have limited resources to respond to the challenge of climate change. Poor countries and poor populations within rich countries will be disproportionately impacted by climate change because of their limited resources for adaptation.¶ Some climate related impacts are difficult to adapt to. For example, extreme weather events, such as storms and floods, are not easily ameliorated by adaptation measures. By investing in the reduction of greenhouse gases, it will offset necessary investments in adaptation in addition to protecting against those adverse effects of climate change for which adaptation is particularly difficult. It isclear that responding to climate change requires both mitigation of greenhouse gases and adaptation to unavoidable change.

### Warming – AT Irreversible

#### Warming is not inevitable – significant cuts solve

Somerville, professor of Oceanography at UC San Diego and coordinating lead author in the 2007 Assessment Report of the Intergovernmental Panel on Climate Change, 2011

(Richard, Mar. 8, “Climate Science and EPA’s Greenhouse Gas Regulations, CQ Congressional Testimony, Lexis,

Thus, atmospheric CO2 concentrations are already at levels predicted to lead to global warming of between 2.0 and 2.4C. The conclusion from both the IPCC and subsequent analyses is blunt and stark - immediate and dramatic emission reductions of all greenhouse gases are urgently needed if the 2 deg C (or 3.6 deg F) limit is to be respected. This scientific conclusion illustrates a key point, which is that it will be governments that will decide, by actions or inactions, what level of climate change they regard as tolerable. This choice by governments may be affected by risk tolerance, priorities, economics, and other considerations, but in the end it is a choice that humanity as a whole, acting through national governments, will make. Science and scientists will not and should not make that choice. After governments have set a tolerable limit of climate change, however, climate science can then provide valuable information about what steps will be required to keep climate change within that limit.

#### Warming is not inevitable – even if temporarily over the tipping point, CO2 concentration can be brought back down.

Dyer, PhD in Middle Eastern history, MA in military history, and environmental author, 2008

(Gwynne, Jan. 1, “Climate Wars”

There is no need to despair. The slow-feedback effects take a long time to work their way through the climate system, and if we could manage to get the carbon dioxide concentration back down to a safe level before they have run their course, they might be stopped in their tracks. As Hansen et al. put it in their paper:   A point of no return can be avoided, even if the tipping level [which puts us on course for an ice-free world] is temporarily exceeded. Ocean and ice-sheet inertia permit overshoot, provided the [concentration of carbon dioxide] is returned below the tipping level before initiating irre­versible dynamic change .... However, if overshoot is in place for centuries, the thermal perturbation will so pen­etrate the ocean that recovery without dramatic effects, such as ice-sheet disintegration, becomes unlikely.   The real, long-term target is 350 parts per million or lower, if we want the Holocene to last into the indefinite future, but for the remainder of this book I am going to revert to the 450 parts per million ceiling that has become common currency among most of those who are involved in climate change issues. If we manage to stop the rise in the carbon dioxide concentration at or not far beyond that figure, then we must immediately begin the equally urgent and arduous task of getting it back down to a much lower level that is safe for the long term, but one step at a time will have to suffice. I suspect that few now alive will see the day when we seriously start work on bringing the concen­tration back down to 350, so let us focus here on how to stop it rising past 450.

### AT Alt Cause: Other Countries – Modeling Solves

#### Action by the US spurs global modeling

Gingrich and Maple, 2008(Newt Gingrich, former speaker of the U.S. House of Representatives, and Terry L. Maple, Professor of Conservation of Behavior at the Georgia Institute of Technology, “Forging a New, Bipartisan Environmental Movement”, “Issues in Science and Technology”, Jan 9 2008, http://www.issues.org/24.2/p\_gingrich.html#,

We believe that many if not all environmental challenges can be resolved by developing new and better technology and by generating best practices in environmental stewardship. By leading the world in the production of innovative environmental tools, the United States will produce the renewable technology that will eventually provide clean energy to the rest of the world. Developing nations, especially China and India, need U.S. expertise to help solve their escalating emissions problems. With the Olympic Games approaching, the Chinese government is frantic to deliver clean air to the world’s best athletes and the masses of visiting spectators. It is likely that China’s struggle to control ambient environmental quality will dominate the daily news as the Olympic competition unfolds. Likewise, the United States’ reputation as a global leader depends on decisive leadership on many pressing environmental fronts, including the pursuit of new international agreements that are more realistic and effective than the Kyoto Accords.

## Wastewater Advantage-Extensions

### Solvency – Dead Zones

#### Omega solves for dead zones

Teague Soderman 12 “Offshore Membrane Enclosure for Growing Algae (OMEGA)” http://sservi.nasa.gov/articles/omega/

When deployed in contaminated and “dead zone” coastal areas, this system may help remediate these zones by removing and utilizing the nutrients that cause them. The forward-osmosis membranes use relatively small amounts of external energy compared to the conventional methods of harvesting algae, which have an energy intensive de-watering process. Potential benefits include oil production from the harvested algae, and conversion of municipal wastewater into clean water before it is released into the ocean. After the oil is extracted from the algae, the algal remains can be used to make fertilizer, animal feed, cosmetics, or other valuable products. This successful spinoff of NASA-derived technology will help support the commercial development of a new algae-based biofuels industry and wastewater treatment.¶ “The reason why algae are so interesting is because some of them produce lots of oil,” said Jonathan Trent, the lead research scientist at NASA Ames Research Center, Moffett Field, Calif. “In fact, most of the oil we are now getting out of the ground comes from algae that lived millions of years ago. Algae are still the best source of oil we know.”¶ Algae are similar to other plants in that they remove carbon dioxide from the atmosphere, produce oxygen as a by-product of photosynthesis, and use phosphates, nitrogen, and trace elements to grow and flourish. Unlike many plants, they produce fatty, lipid cells loaded with oil that can be used as fuel.¶ “The inspiration I had was to use offshore membrane enclosures to grow algae. We’re going to deploy a large plastic bag in the ocean, and fill it with sewage. The algae use sewage to grow, and in the process of growing they clean up the sewage,” said Trent.¶ It is a simple, but elegant concept. The bag will be made of semi-permeable membranes that allow fresh water to flow out into the ocean, while retaining the algae and nutrients. The membranes are called “forward-osmosis membranes.” NASA is testing these membranes for recycling dirty water on future long-duration space missions. They are normal membranes that allow the water to run one way. With salt water on the outside and fresh water on the inside, the membrane prevents the salt from diluting the fresh water. It’s a natural process, where large amounts of fresh water flow into the sea.¶ Floating on the ocean’s surface, the inexpensive plastic bags will be collecting solar energy as the algae inside produce oxygen by photosynthesis. The algae will feed on the nutrients in the sewage, growing rich, fatty cells. Through osmosis, the bag will absorb carbon dioxide from the air, and release oxygen and fresh water. The temperature will be controlled by the heat capacity of the ocean, and the ocean’s waves will keep the system mixed and active.¶ When the process is completed, biofuels will be made and sewage will be processed. For the first time, harmful sewage will no longer be dumped into the ocean. The algae and nutrients will be contained and collected in a bag. Not only will oil be produced, but nutrients will no longer be lost to the sea. According to Trent, the system ideally is fail proof.

#### OMEGA can remediate dead zones

Sci Tech Daily, 4/17/2012, “NASA explores OMEGA system for alternative aviation fuels,” <http://scitechdaily.com/nasa-explores-omega-system-for-alternative-aviation-fuels/>

Offshore Membrane Enclosures for Growing Algae (OMEGA) is an innovative method to grow algae, clean wastewater, capture carbon dioxide and to ultimately produce biofuel without competing with agriculture for water, fertilizer or land.¶ NASA’s OMEGA system consists of large flexible plastic tubes, called photobioreactors. Floating in seawater, the photobioreactors contain freshwater algae growing in wastewater. These algae are among the fastest growing plants on Earth.¶ The algae use energy from the sun, carbon dioxide and nutrients from the wastewater to produce biomass that can be converted into biofuels as well as other useful products such as fertilizer and animal food. The algae clean the wastewater by removing nutrients that otherwise would contribute to marine deadzone formation.¶ NASA’s project goals are to investigate the technical feasibility of a unique floating algae cultivation system and prepare the way for commercial applications. Research by scientists and engineers has demonstrated that OMEGA is an effective way to grow microalgae and treat wastewater on a small scale.

#### **OMEGA farms clean up dead zones**

Narasimhan 14

OMEGA – Offshore Membrane Enclosure for Growing Algae¶ [Narasimhan](http://algae.gallery/?author=2) / April 18, 2014 http://algae.gallery/?p=64

Offshore Membrane Enclosures for Growing Algae (OMEGA) is an innovative method to grow algae, clean wastewater, capture carbon dioxide and to ultimately produce biofuel without competing with agriculture for water, fertilizer or land.¶ NASA’s OMEGA system consists of large flexible plastic tubes, called photobioreactors. Floating in seawater, the photobioreactors contain freshwater algae growing in wastewater. These algae are among the fastest growing plants on Earth.¶ The algae use energy from the sun, carbon dioxide and nutrients from the wastewater to produce biomass that can be converted into biofuels as well as other useful products such as fertilizer and animal food. The algae clean the wastewater by removing nutrients that otherwise would contribute to marine deadzone formation.

### Solvency – Wastewater

#### The production of algae biofuels can treat wastewater and capture agricultural runoff

Phys.org, 5/30/2014, “going green with algae,” <http://phys.org/news/2014-05-green-algae.html>

Because algae also needs nitrogen and phosphorus to survive, it can remove those elements from municipal and industrial wastewater before it's discharged into rivers and lakes, reducing the need for expensive treatments typically used to clean wastewater. It can also be used to capture fertilizers in agricultural runoff, then used as a fertilizer itself.¶ The Research Institute has been performing research, testing and development of algae and algae-growing systems for pollution control and alternative energies since 2009 under funding from the Air Force Research Laboratory Materials and Manufacturing Directorate. Initial research was focused on testing varieties of algae and light and other growing conditions for optimal production, as well as best methods of extracting oil.¶ "We discovered that there are no 'best strains' of algae, but that the key factors to high yield are environmental – factors such as weather and temperature, which can be so unpredictable," Sidhu said. "That's why most systems are open, such as natural or man-made ponds, and found in warmer climates.

#### **OMEGA farms can treat waste water**

Trent et al 2012

Energy Research and Development Division ¶ FINAL PROJECT REPORTOFFSHORE MEMBRANE ¶ ENCLOSURES FOR ¶ GROWING ALGAE (OMEGA) ¶ ¶ A Feasibility Study for Wasterwater to ¶ Biofuels Patrick Wiley, Linden Harris, Sasha Tozzi, ¶ Tsegereda Embaye, Kit Clark, Brandi McKuin, Zbigniew Kolber, Russel Adams, Hiromi ¶ Kagawa, Tra‐My Justine Richardson, John Malinowski, Sigrid Reinsch, Colin Beal, Matthew A. ¶ Claxton, Emil Geiger, Jon Rask, Todd Lane, Laura Carney and J. Elliot Campbell. http://www.energy.ca.gov/2013publications/CEC-500-2013-143/CEC-500-2013-143.pdf

OMEGA has the potential of co-locating microalgae cultivation with two major waste-streams ¶ from coastal cities: wastewater and CO2. By situating OMEGA systems in the vicinity of ¶ offshore wastewater outfalls and CO2 sources, such as near-shore power plants, OMEGA can ¶ transform these waste streams into resources that produce biofuels and treat wastewater ¶ without competing with agriculture for water, fertilizer, or land [12]. The experiments ¶ presented here explored the technical feasibility of OMEGA, using a 110-liter prototype system ¶ that was built and tested over a 23-day period. Microalgae in secondary-treated wastewater ¶ circulated through PBRs floating in seawater tanks and through a gas exchange and harvesting ¶ column, while a custom I&C system monitored and controlled critical culture parameters. ¶ Analyses indicated that the system was supersaturated with dissolved oxygen during the day ¶ due to photosynthesis, but at the highest light levels there was only slight photoinhibition. The ¶ system rapidly used the NH3-N in wastewater and had a CO2 conversion efficiency of >50 ¶ percent; better than the 10-20 percent conversions in other systems [21, 38]. The areal ¶ productivity of the system averaged 14.1 g m-2 day-1 overall with peaks above 20 g m-2 day-1 ¶ values consistent with reported U.S. average microalgae productivity of 13.2 g m-2 day-1 [58]. ¶ The microalgae consistently removed >90 percent of the NH3-N from the secondary-treated ¶ municipal wastewater tested. This result, combined with observations that the OMEGA system ¶ can remove other wastewater contaminants [59], suggests that a scaled-up system could ¶ provide effective wastewater treatment services. ¶ Many open questions remain with regard to the feasibility of large-scale OMEGA systems. The ¶ small-scale prototype OMEGA system was intended for experimentation and was not designed ¶ for energy efficiency or economical scale up. For large-scale OMEGA deployment dense ¶ configurations of PBRs, improved hydrodynamics, optimized pumping and mixing, and more ¶ sophisticated process control algorithms will be needed to increase yields, improve the energy ¶ return on investment (EROI), and lower operating costs. In addition to the EROI and economics, ¶ questions about the impact of biofouling, concerns about engineering systems that can cope ¶ with marine environments, and environmental issues around both environmental impact and ¶ environmental regulations will need to be answered. It remains to be seen if the need for ¶ sustainable biofuels will drive the innovation necessary to address these questions to develop ¶ large-scale OMEGA systems.

#### OMEGA is the best viable solution for clean fuel and wastewater treatment.

Trent 12 (Jonathon, studied at Scripps Institution of Oceanography, UC-San Diego, specializing in extremophiles. He is lead scientist on the OMEGA project at NASA's Ames Research Center in California. Prepared for: California Energy Commission Prepared by: NASA Ames Research Center “OFFSHORE MEMBRANE ENCLOSURES FOR GROWING ALGAE (OMEGA) A Feasibility Study for Wasterwater to Biofuels” California Energy Commission. Publication number: CEC‐500‐2013‐143. December 2012, http://www.energy.ca.gov/2013publications/CEC-500-2013-143/CEC-500-2013-143.pdf)//EAZYE

Recent recognition of the need for alternative energy sources, especially those sources that meet “carbon neutral”, “sustainable, or “renewable” criteria, has led to extensive research on algae cultivation for biofuels. Energy and economic considerations have established the need to integrate and co-locate algae cultivation with wastewater treatment facilities, which for coastal cities can be done with OMEGA. In two experimental OMEGA systems (~110 and ~1600 L) 22 pharmaceuticals and personal care products (PPCPs), including three steroids, and six metals were investigated. Some PPCPs were reduced by >95 percent, while others by <10 percent . Concentrations of zinc, copper, chromium, mercury and lead were all significantly reduced, but not nickel. DOC concentrations decreased, although increases in BOD and alteration in organic carbon composition were observed, suggesting that post-treatment to meet discharge requirements may be necessary. OMEGA, as well as other algae cultivation systems, warrant further investigation for their contribution to reducing wastewater-derived contaminants and advanced wastewater treatment.

### Solvency - AT Not Energy Efficient

#### Offshore placement solves for energy efficiency

Trent 12 (Jonathon, studied at Scripps Institution of Oceanography, UC-San Diego, specializing in extremophiles. He is lead scientist on the OMEGA project at NASA's Ames Research Center in California. This essay is based on a talk he gave at TEDGlobal 2012 and a paper in Biofuels. “Grow Your Own Energy” Slate, September 3rd 2012, <http://www.slate.com/articles/health_and_science/new_scientist/2012/09/algae_for_biofuel_omega_project_has_success_in_california_ready_to_scale_up_.html)//EAZYE>

A solution occurred to me: For coastal cities, we should try a system I call OMEGA: Offshore Membrane Enclosures for Growing Algae. Some 40 to 60 percent of Earth’s population lives near a coast, most of the biggest cities are near a coast, and nearly all coastal cities discharge wastewater offshore. OMEGA uses PBRs made from cheap, flexible plastic tubes floating offshore, and filled with wastewater, to grow freshwater, oil-producing algae. It would be easier to build the systems in protected bays, but breakwaters could also be constructed to control waves and strong currents. The water need not be deep or navigable, but a few things are crucial, including temperature, light, water clarity, frequency and severity of storms, boat traffic, nature, and wildlife conservation. Beyond solving the problem of proximity to wastewater plants, there are other advantages to being offshore. OMEGA uses buoyancy, which can be easily manipulated, to move the system up and down, influencing exposure to surface waves and adjusting light levels. And the overheating problem is eliminated by the heat capacity of the surrounding seawater. The salt gradient between seawater and wastewater can also be exploited to drive forward osmosis. Using a semipermeable membrane, which allows water, but not salt, pollutants, or algae to pass through, wastewater is drawn into the saltwater with no added energy. In the process, algae are concentrated in preparation for harvesting and the wastewater is cleaned, first by the algae, and then by forward osmosis. This produces water clean enough to release into the marine environment or recover for reuse.

### AT Oceans Resilient

#### Pollution will push the ocean past resiliency

NOC 11 National Oceaography Centre, National Environment Research Council. <http://noc.ac.uk/science-technology/seas-under-threat/marine-pollution/chemical-pollution>  July 5, 2011 “Chemical Pollution.”

Life in the deep sea may be less resilient to its effects. Deep-sea organisms are typically subjected to a smaller range of environmental variation than shallow-water organisms and they live in areas that have not previously been affected by many chemical pollutants. The lifestyles of deep-sea organisms may be less conducive to dealing with chemical stress. For example, many deep-sea animals have low metabolic rates, reduced growth rates, greater age of maturity and higher reproductive investment than shallow-water organisms. These factors likely increase the timescales for recovery of deep-water environments compared to shallow areas.¶ Although marine pollution has a long history, until the twentieth century most scientists believed that the vast oceans had virtually unlimited ability to dilute and render pollution harmless. Increasing evidence to the contrary, including in the open ocean outside of regional jurisdiction, resulted in the formulation of significant international legislation to counter pollution. These laws have been effective at reducing some types of pollution that could reach the deep sea, particularly pollution from shipping, and regulating other polluting activities. However, despite regulation chemical pollution is becoming a more important stressor to deep-sea organisms and ecosystems.

### AT Pollution Turn

#### Non-unique – even if the bags spill, the water is polluted anyway

Katie Howell, 5/12/2009, New York Times, “NASA bags algae, wastewater in bid for aviation fuel,” <http://www.nytimes.com/gwire/2009/05/12/12greenwire-nasa-bags-algae-wastewater-in-bid-for-aviation-12208.html>

The system is foolproof, he said. Even if the OMEGA bags leak, the salty ocean water would kill the algae, preventing the escape of an invasive species.¶ "Freshwater algae can't compete in the marine environment," Trent said. "We're not putting something out there that could become an invasive species."¶ And if the wastewater spills, he said, "the only thing we're putting in the water is already in the ocean anyway."

#### The omega system causes no harm to wildlife - Observations prove.

Loury 2011

(Algae experiment may be 'game changer'¶ Scientists aim to create biofuel¶ By ERIN LOURY ¶ Herald Staff Writer¶ POSTED: 11/22/2011 01:26:34 AM PST0 COMMENTS| UPDATED: 3 YEARS AGO http://www.montereyherald.com/news/ci\_19389410, Date Accessed: 6.22.14)//BSpencer

OMEGA scientist Linden Harris said the ultimate goal of the project is to benefit the environment, so it is important to investigate potential detrimental effects.¶ "I think a lot of people have been a little freaked out about ... putting tons of plastic in the ocean and altering the environment," she said. "And that's a valid concern, so we just want to be able to say, 'This is exactly how we think it will affect the environment.'"¶ **Not sea trash**¶ **Trent said the OMEGA system is far from ocean trash.**¶ **"These plastic structures we're building are extremely valuable," he said. "It's not like a plastic bottle or plastic bag that's used one time and carelessly discarded, and ends up in the plastic gyre in the Pacific Ocean**."¶ He said the goal of the OMEGA project is to create a "cradle to cradle system," **where all products and materials are reused and recycled, including the plastic membranes.**¶ **With respect to wildlife, "We definitely want to make sure we have a structural design that's not going to entangle an animal or trap them underneath it,"** said Colleen Young, a marine mammal and seabird scientist working with the project.¶ **Observers have noted that birds will stand on the bag in Moss Landing Harbor and nibble on the fouling seaweeds, while sea otters will sometimes climb onto it. The team has tested the durability of the plastic to animal teeth, beaks and claws**.¶ "I haven't seen anything alarming, but I am still worried that sea otters could break their teeth chewing on hard plastic valves," Young said.¶ She said at the moment, the OMEGA system does not appear to either greatly benefit or harm wildlife.¶

## Add-On Scenarios

### Add-On Scenario - Gulf of Mexico

#### The dead zone in the Gulf of Mexico is expanding

Main 13 (DOUGLAS MAIN is a staff writer for NBC) July 30th 2013 “Gulf of Mexico dead zone is the size of Connecticut” http://www.nbcnews.com/science/science-news/gulf-mexico-dead-zone-size-connecticut-f6C10798946

The dead zone that has formed in the Gulf of Mexico this summer is smaller than predicted, but is still larger than average, spanning an area roughly the size of Connecticut. This zone, an area without oxygen and almost completely devoid of life that crops up every summer, covers 5,840 square miles (15,125 square kilometers), according to the National Oceanic and Atmospheric Administration (NOAA).¶ In June, NOAA predicted the dead zone would be at least 20 percent larger this summer, expecting it to take up at least 7,286 square miles (18,871 square km).¶ Dead zones are the indirect result of nutrients, largely from fertilizer use, running off into rivers and then into bodies of water such as the gulf. Once these excess nutrients reach the ocean, they fuel algae blooms. The algae then die and decompose in a process that consumes oxygen and creates oxygen-free areas where fish and other aquatic creatures can't survive. This zone can have serious impacts on commercial and recreational fisheries on the Gulf Coast, causing fish die-offs.¶ But the dead zone this summer, the time of year when the phenomenon occurs, is larger than average: Over the past five years, the average dead zone has covered 5,176 square miles (13,405 km), according to NOAA. That's more than twice the 1,900-square- mile (4,921 square km) goal set by the Gulf of Mexico / Mississippi River Watershed Nutrient Task Force, a group that seeks to reduce the size of this lifeless area, according to NOAA.

#### Algae farms can stop the dead zone

Mose Buchele, 12/9/2011, State Impact, “tiny algae could be a big source of power,” <https://stateimpact.npr.org/texas/2011/12/09/tiny-algae-could-be-a-big-source-of-power/>

It’s not a quiet place. Machines shake beakers in the corners to aerate the algae. AC units hum to keep samples at the right temperature. On a recent tour of the collection, Dr. Jerry Brand, the director of the Center, held up a sample of his favorite algae.¶ “Each of these little balls contains 512 cells. And they just swirl and tumble like [they're] dancing on a dance floor,” he said. It’s easy to think of each little jar as a world unto itself. But these small organisms could one day bring major benefits to life outside the university walls.¶ “People see algae as pond scum. We see algae as fuel, cures for cancer nutricuticals, sources of chemicals that are greener than we’ve ever had before,” said Dr. Robert Hebner, director of the school’s Center for Electromechanics.¶ Hebner is at the forefront of algae research. His interest began about five years ago when a colleague pointed out the challenge of extracting naturally occurring oils from algae.¶ “I went to my white board and I started writing down some circuit to do this,” he remembers.¶ Today, the fruits of those early ideas are visible at Hebner’s lab at the UT Pickle Research Center. That’s where a huge algae process device separates algae from oil. It’s an ongoing experiment into the green stuff’s potential as a biofuel.¶ Last summer, Hebner brought the device to a sewage treatment plant outside of Austin, where he produced biofuel from the naturally occurring algae there. That sums up the promise: Algae takes what we generally think of as waste — be it sewage, C02 emissions or, fertilizer runoff — and uses it to grow.¶ “The US Air Force even had an ambitious plan to flow the Mississippi River through an algae plant so you don’t create the dead zone in the gulf of Mexico,” said Hebner.¶ Although that never got past the proposal stage, entrepreneurs are looking for ways to make some greenbacks out of that green slime. Hoyt Thomas is with Open Algae, a group trying to commercialize the device in Hebner’s Lab.

#### We are at a tipping point – continued expansion of the dead zone collapses biodiversity in the gulf

Jackson 2012

(Midwest corn boom may expand 'dead zone'¶ Henry C. Jackson, The Associated Press | Updated Oct 26, 2012¶ http://www.dailyillini.com/news/article\_b1d946e0-8dc6-5e4c-8948-cb952d3bca1c.html?mode=jqm,Date Accessed: 6.22.14)//BSpencer

**Because of rising demand for ethanol, American farmers are growing more corn than at any time since World War II.** **And sea life in the Gulf of Mexico is paying the price.¶ The nation's corn crop is fertilized with millions of pounds of nitrogen-based fertilizer. And when that nitrogen runs off fields in Corn Belt states, it makes its way to the Mississippi River and eventually pours into the Gulf, where it contributes to a growing "dead zone**" - a 7,900-square-mile patch so depleted of oxygen that fish, crabs and shrimp suffocate.¶ The **dead zone was discovered in 1985 and has grown fairly steadily since then, forcing fishermen to venture farther and farther out to sea to find their catch. For decades, fertilizer has been considered the prime cause of the lifeless spot**.¶ With demand for corn booming, **some researchers fear the dead zone will expand rapidly, with devastating consequences.¶ "We might be coming close to a tipping point**," said Matt Rota, director of the water resources program for the New Orleans-based Gulf Restoration Network, an environmental group. **"The ecosystem might change or collapse as opposed to being just impacted**."¶

### Add-On Scenario – Ocean Acidification

#### OMEGA farms solve ocean acidification

Trent et al 2010

OFFSHORE MEMBRANE ENCLOSURES FOR GROWING ALGAE (OMEGA): ¶ A SYSTEM FOR BIOFUEL PRODUCTION, WASTEWATER TREATMENT, AND ¶ CO2 SEQUESTRATION Jonathan Trent1\*¶ , Tsegereda Embaye2¶ , Patrick Buckwalter3¶ , Tra-My Richardson3¶ , Hiromi Kagawa2¶ , Sigrid ¶ Reinsch1¶ , and Mary Martis4 <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100039342.pdf>

OMEGA products and services do not compete with ¶ agriculture or damage marine ecosystems. Indeed, ¶ OMEGA is meant to improve the marine environment by ¶ removing nutrients that are currently contributing to the ¶ formation of dead zones and by sequestering CO2 that is contributing to ocean acidification. The hope is that ¶ based on the results on the demonstration, people ¶ around the world will be motivated to develop OMEGA ¶ systems for their locations. Projects like OMEGA will ¶ require local experts supported by government agencies ¶ and private investors who all recognize the magnitude of ¶ global problems and the urgency of finding solutions. If ¶ such experts can be mobilized and openly share ¶ information, it is estimated that OMEGA technology can ¶ be developed to significant scales within 10 years. It is ¶ impossible to predict as yet if OMEGA is feasible and ¶ scalable, but having just emerged from the warmest ¶ decade on record, we enter a new era with the ¶ knowledge that it is imperative that civilization move ¶ without delay from hunting-and-gathering energy to ¶ sustainably and responsible cultivating and harvesting it. ¶ As we consider options for future energy “farms,” the ¶ oceans emerge as the world’s most promising energy ¶ frontier.

#### Ocean acidification is increasing – that causes extinction

Kristof 6 (NICHOLAS D. KRISTOF, American journalist, author, op-ed columnist, and a winner of two Pulitzer Prizes, “Scandal Below the Surface”, Oct 31, 2006, http://select.nytimes.com/2006/10/31/opinion/31kristof.html?\_r=1, CMR)

If you think of the earth’s surface as a great beaker, then it’s filled mostly with ocean water. It is slightly alkaline, and that’s what creates a hospitable home for fish, coral reefs and plankton — and indirectly, higher up the food chain, for us. But scientists have discovered that the carbon dioxide (CO2) we’re spewing into the air doesn’t just heat up the atmosphere and lead to rising seas. Much of that carbon is absorbed by the oceans, and there it produces carbonic acid — the same stuff found in soda pop. That makes oceans a bit more acidic, impairing the ability of certain shellfish to produce shells, which, like coral reefs, are made of calcium carbonate. A recent article in Scientific American explained the indignity of being a dissolving mollusk in an acidic ocean: “Drop a piece of chalk (calcium carbonate) into a glass of vinegar (a mild acid) if you need a demonstration of the general worry: the chalk will begin dissolving immediately.” The more acidic waters may spell the end, at least in higher latitudes, of some of the tiniest variations of shellfish — certain plankton and tiny snails called pteropods. This would **disrupt the food chain,** possibly killing off many whales and fish, and rippling up all the way to humans. We stand, so to speak, on the shoulders of plankton. “There have been a couple of very big events in geological history where the carbon cycle changed dramatically,” said Scott Doney, senior scientist at the Woods Hole Oceanographic Institution in Massachusetts. One was an abrupt warming that took place 55 million years ago in conjunction with acidification of the oceans and **mass extinctions**. Most scientists don’t believe we’re headed toward a man-made variant on that episode — not **yet**, at any rate. But many worry that we’re hurtling into unknown dangers. “Whether in 20 years or 100 years, I think marine ecosystems are going to be dramatically different by the end of this century, and that’ll lead to **extinction events**,” Mr. Doney added. “This is the only habitable planet we have,” he said. “The damage we do is going to be felt by **all the generations to come.”** So that should be one of the great political issues for this century — the vandalism we’re committing to our planet because of our refusal to curb greenhouse gases. Yet the subject is barely debated in this campaign. Changes in ocean chemistry are only one among many damaging consequences of carbon emissions. Evidence is also growing about the more familiar dangers: melting glaciers, changing rainfall patterns, rising seas and more powerful hurricanes. Last year, the World Health Organization released a study indicating that climate change results in an extra 150,000 deaths and five million sicknesses each year, by causing the spread of malaria, diarrhea, malnutrition and other ailments. A report prepared for the British government and published yesterday, the Stern Review on the Economics of Climate Change, warned that inaction “could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century.” If emissions are not curbed, climate change will cut 5 percent to 20 percent of global G.D.P. each year, declared the mammoth report. “In contrast,” it said, “the costs of action — reducing greenhouse gas emissions to avoid the worst impacts of climate change — can be limited to around 1 percent of global G.D.P. each year.” Some analysts put the costs of action higher, but most agree that it makes sense to invest far more in alternative energy sources, both to wean ourselves of oil and to reduce the strain on our planet. We know what is needed: a carbon tax or cap-and-trade system, a post-Kyoto accord on emissions cutbacks, and major research on alternative energy sources. But as The Times’s Andrew Revkin noted yesterday, spending on energy research and development has fallen by more than half, after inflation, since 1979.

### Add-On Scenario - Waterborne Diseases

#### Wastewater contributes to the spread of waterborne diseases

USGS 14 (United States Geological Survey. Department of the Interior. age Last Modified: Monday, 17-Mar-2014http://water.usgs.gov/edu/wuww.html)//EAZYE

Clean water is critical to plants and animals that live in water. This is important to the fishing industry, sport fishing enthusiasts, and future generations. Wildlife Habitats Our rivers and ocean waters teem with life that depends on shoreline, beaches and marshes. They are critical habitats for hundreds of species of fish and other aquatic life. Migratory water birds use the areas for resting and feeding. Recreation and Quality of Life Water is a great playground Goes to page with picture plus text for us all. The scenic and recreational values of our waters are reasons many people choose to live where they do. Visitors are drawn to water activities such as swimming, fishing, boating and picnicking. Health Concerns If it is not properly cleaned, water can carry disease. Since we live, work and play so close to water, harmful bacteria have to be removed to make water safe. Effects of wastewater pollutants If wastewater is not properly treated, then the environment and human health can be negatively impacted. These impacts can include harm to fish and wildlife populations, oxygen depletion, beach closures and other restrictions on recreational water use, restrictions on fish and shellfish harvesting and contamination of drinking water. Environment Canada provides some examples of pollutants that can be found in wastewater and the potentially harmful effects these substances can have on ecosystems and human health: decaying organic matter and debris can use up the dissolved oxygen in a lake so fish and other aquatic biota cannot survive; excessive nutrients, such as phosphorus and nitrogen (including ammonia), can cause eutrophication, or over-fertilization of receiving waters, which can be toxic to aquatic organisms, promote excessive plant growth, reduce available oxygen, harm spawning grounds, alter habitat and lead to a decline in certain species; chlorine compounds and inorganic chloramines can be toxic to aquatic invertebrates, algae and fish; bacteria, viruses and disease-causing pathogens can pollute beaches and contaminate shellfish populations, leading to restrictions on human recreation, drinking water consumption and shellfish consumption; metals, such as mercury, lead, cadmium, chromium and arsenic can have acute and chronic toxic effects on species. other substances such as some pharmaceutical and personal care products, primarily entering the environment in wastewater effluents, may also pose threats to human health, aquatic life and wildlife.

### Gulf of Mexico Dead Zone – Hurts Biodiversity

#### The dead zone in the gulf is getting worse – it is pushing the entire ecosystem towards collapse

Russell Gold, 8/12/2009, Wall street journal, “entrepreneurs wade into the dead zone,” <http://online.wsj.com/news/articles/SB125003834803724511>

Every spring, fertilizer runoff from the U.S. Mississippi River floods into the Gulf of Mexico, causing a massive algae bloom that leads to a giant oxygen-deprived "dead zone" where fish can't survive.¶ Now, this annual problem is getting new attention, not from marine scientists but from entrepreneurs looking for a new domestic source of fuel. And one start-up sees fish themselves being part of the process.¶ The algae blooms are spawned each year as the farmland runoff from as far away as Montana flows into rivers, eventually reaching the Mississippi and flowing into Louisiana bayous and out into the Gulf of Mexico. These nutrients are a buffet for the floating algae, or phytoplankton, which are simple sea organisms that eat and reproduce quickly. This algae bloom eventually sinks and feeds an array for bacteria, which suck up so much oxygen that fish and plants either move away or perish.¶ These so-called hypoxic areas exist around the world, and there were as many as 200 in North America in the spring, says Robert J. Diaz, a professor of marine science at the College of William & Mary in Virginia. The Gulf of Mexico dead zone is the second largest in the world, after one in the Baltic Sea.¶ Scientists have been studying dead zones for decades, and the concern about their effect on ocean life has grown. The Louisiana seafood industry worries that dead zones threaten the ecosystems that support the state's $1 billion shrimp industry as well as other fisheries. Environmental groups are concerned that the runoff from agricultural fertilizer is threatening a natural ecosystem and pushing it toward collapse.

# Offcase Answers

## AT Disadvantages

### AT Politics – Google Link Shield

#### Google likes the plan

Emma Fitzpatrick, 8/12/2013, RE New Economy, “how sewage is powering algae production of the future,” <http://reneweconomy.com.au/2013/how-sewage-is-powering-algae-production-of-the-future-13157>

But the EU isn’t the only organisation to make new ground on the sewage to fuel notion. The American space program, NASA, has begun a new program called OMEGA, which looks at growing and harvesting algae from sewage outlets within the ocean.¶ A flexible bag system, or photo-bioreactors, will allow freshwater algae to feed off a sewage outpost within the ocean. Algae will feed off the sewage nutrients while creating a by-product of freshwater released back into the ocean through forward-osmosis.¶ When each bag system has reached capacity – which NASA suspects will take approximately 10 days – the algae is harvested for its oil content and converted in to biofuel.¶ The project relies on the kinetic power of the ocean to mix algae and nutrient within the bags while also using abundant sources carbon dioxide and sunlight.¶ The added benefit of setting up project within the ocean is the idea of space. The bags are hypothesised to be around a quarter of an acre in size could be dotted along the US coast.¶ The algal systems stored beneath water offshore provide an alternative to the terrestrial pond systems currently in place with the majority of algae producers.¶ The OMEGA project has also drawn support from the philanthropic arm of Google.

#### Google has massive sway in Congress – that shields the link

Bloomberg News, 11/5/2013, “google amassing army of lobbyists to sway capitol hill,” <http://www.newsmax.com/Newsfront/google-lobbyists-spending-capitol-hill/2013/11/05/id/534874/>

Google Inc. is moving its Washington office closer to Capitol Hill after spending $18.2 million on lobbying, more than Northrop Grumman Corp. and enough to rank the technology company as the eighth-biggest advocacy spender.¶ It’s an investment that’s already paying off in increased influence. Google has hired lobbyists and boosted political giving on its way to wins at the U.S. Federal Communications Commission and Federal Trade Commission, and it has entrée to the White House where an employee is helping fix the ailing Obamacare website.¶ The buildup from an office with two lobbyists 10 years ago to one now with at least 11, and the resulting web of connections, will help as Google seeks to end National Security Agency intrusions into its data that the company calls an “outrage.”¶ “Google has put itself in the position of being heard when they need to be heard,” Jeffrey Birnbaum, president of BGR Public Relations, a Washington-based media strategy firm, said in an interview. “Decision makers at least know what Google is thinking and what policies it prefers.”¶ The operator of the world’s most popular Internet search engine has learned a lesson that Microsoft Corp. absorbed the hard way, when neglect of Washington in the 1990s preceded an antitrust lawsuit.¶ Google adopted the tools for gaining influence: campaign cash, attentive lobbyists and friends on both sides of the partisan divide. Last year the Silicon Valley company hired former Republican Representative Susan Molinari to lead its Washington office, and Chairman Eric Schmidt was a high-profile contributor and backer of President Barack Obama’s re-election.

### AT Politics – Plan Popular

#### Congress won’t backlash against the OMEGA program

G.C.R., 4/20/2012, Green Car Reports, “NASA ready to show off algae biofuel research project,” <http://www.greencarreports.com/news/1075546_nasa-ready-to-show-off-algae-biofuel-research-project>

Algae, especially freshwater algae, is an attractive biofuel due to its ability to grow rapidly while producing lipid cells bursting with oil.¶ Other biofuel crops just can’t compete: according to NASA, some algae can produce more than 2,000 gallons of oil per acre per year, compared to only 600 gallons for palm. Soy beans fare even worse, at only 50 gallons per acre per year.¶ Legislators who are taking aim at the Obama Administration’s algae biofuel initiatives will once again have to rethink their plan if they want to take a potshot at OMEGA.

#### There is bi-partisan support for Nasa projects ,and further research and development of algae activities - 2 recent bills prove.

**Johnson 6/9**

(http://democrats.science.house.gov/press-release/house-passes-nasa-reauthorization-act-2014-and-harmful-algal-bloom-and-hypoxiaHouse Passes NASA Reauthorization Act of 2014 and the Harmful Algal Bloom and Hypoxia Research and Control Amendments Act, Eddie Benice Johnson¶ JUN 9, 2014, Date Accessed:6.28.14)//BSpencer

(Washington, DC) **– The House of Representatives today passed H.R. 4412, the National Aeronautics and Space Administration Authorization Act of 2014, and** S. 1254, the Harmful **Algal Bloom** and Hypoxia **Research and Control** Amendments 8r.H.R. **4412 authorizes funding for one year and provides policy direction for NASA**.¶ ¶ Ranking Member of the Full Committee, Eddie Bernice Johnson (D-TX), said of the bill, “This Act has come a long way from its original state nearly a year ago when the Committee on Science, Space, and Technology on which I serve as Ranking Member passed a different version of the bill on a party-line vote—a departure from the Committee’s traditional bipartisan approach to NASA. However, much has changed since that time, and I want to recognize the efforts of the Committee leadership, including Chairman Lamar Smith and especially Space Subcommittee Chairman Steven Palazzo and Ranking Member Donna Edwards, for their dedication and willingness to work together with me to achieve **this bipartisan Committee-passed bill, H.R. 4412, the NASA Authorization Act of 2014**. While this is not a perfect bill, especially in terms of its short duration and lack of meaningful funding guidance, the bill in **its present form includes many important policy provisions that help guide the future of NASA at a critical time** for our space program.”¶ ¶ Space Subcommittee Ranking Member, Donna F. Edwards (D-MD), said, “**NASA is recognized across the world as a symbol of our greatness as a nation and for leadership in science and technology.** In Maryland, NASA’s Goddard Space Flight Center supports more than 15,000 civil service and private sector jobs, including highly skilled occupations such as engineers, technicians, mathematicians, and scientists. NASA also collaborates extensively with Maryland’s high-tech business sector. These collaborations encourage the expansion of the skilled workforce that has made Maryland a leader in research and technology and grown our state’s economy. The **NASA Authorization Act of 2014 builds on the bipartisan support that Congress has given NASA as a multi-mission agency with programs in space and Earth science, aeronautics, human spaceflight, and exploration**. This bill provides important policy direction that will strengthen our nation’s space program in Maryland and across our country. I look forward to Senate action and getting this bill to the President for his signature.”¶ ¶ **S. 1254 reauthorizes the Harmful Algal Blooms and Hypoxia Research and Control Act. Harmful algal blooms (HABs) occur when colonies of algae grow out of control while producing toxic or harmful effects on people, fish, shellfish, marine mammals, and birds. The bill maintains** and enhances an interagency program led by the National Oceanic and Atmospheric **Administration (NOAA), which will be responsible for promoting a national strategy to help communities understand, predict, control and mitigate freshwater and marine HAB and hypoxia events; enhancing, coordinating, and assessing the activities of existin**g HABs and hypoxia p**rograms; providing for development of a comprehensive research plan and action strategy**, including a regional approach to understanding and responding to HAB events; and requiring an assessment and plan for Great Lakes HABs and hypoxia.

#### Algae biofuels have bipartisan support – empirics

Rosenthal 12 (Mary Rosenthal, executive director of the Algae Biomass Organization, “THE ALGAE BIOFUEL TAX CREDIT” August 2, 2012, http://www.algaebiomass.org/the-algae-biofuel-tax-credit/)

Today, the Senate Finance Committee approved the Family and Business Tax Cut Certainty Act of 2012.¶ The bill, which received bipartisan support in the Committee, would extend the tax credit for the production of cellulosic biofuel through the end of 2013.¶ The bill would also extend the cellulosic biofuel tax credit to algae-based fuel for the first time. These provisions are part of a larger legislative package that would extend dozens of tax credits that have either expired or are set to expire at the end of this year.¶ The full Senate is not expected to vote on the legislation until September at the earliest. However, the bipartisan support for the inclusion of algae-based biofuel in the Senate Finance Committee is a significant milestone that will put the algae industry in an excellent position going into the legislative debates ahead.

#### Algae is popular – house already passed algae bills, doesn’t spark biofuel controversy, and numerous lobbies support

Real 10 (Natalia Real, journalist and technical writer, published in FIS, news center specializing in energy and fishing industry, “HR passes algae biofuel tax bill” October 1, 2010 http://www.fis.com/fis/worldnews/worldnews.asp?l=e&country=0&special=&monthyear=&day=&id=38404&ndb=1&df=0)

A bill meant to give tax breaks to companies working on algae feedstocks-generated biofuel has been approved by the US House of Representatives. The Algae-based Renewable Fuel Promotion Act (HR 4168) was sponsored by New Mexico Congressman Harry Teague and has a corresponding bill in the Senate that was introduced by Senator Bill Nelson (D, Florida) which is awaiting action after being referred to the Senate Finance Committee. Teague’s HR 4168 modifies the Internal Revenue Coded such that algae-based fuels can qualify for benefits now going to cellulosic biofuel makers. The bill includes a USD 1.01 per gal production tax credit and 50 per cent bonus depreciation for property employed to produce algae-based biofuel. Congressman Harry Teague , D-NM. (Photo: sapphireenergy)¶ The bill defines "algae-based biofuel" as “any liquid fuel which is produced from the biomass of an algal organism (in essence, an organism that is primarily aquatic and classified as a non-vascular plant),” according to the Congressional Research Service, Feedstuffs reports.¶ “[…] The House sent an unmistakable message of bipartisan support to the hundreds of companies, scientists, entrepreneurs and government agencies working to accelerate the development of algae-based fuels, which will create jobs, decrease emissions and reduce our nation’s dependence on imported fossil fuels,” told Mary Rosenthal, executive director of the Algal Biomass Organisation (ABO) trade group, reports BrighterEnergy.org. “The passage of this bill is a huge first step towards our goal of creating parity for algae-based biofuels within the tax code and among various other government programmes.”¶ This bipartisan bill was not controversial and passed on the House “suspension calendar,” or with no objections and without a roll call vote this past week. It also received backing from Mary Bono Mack (R-CA), Dave Reichert (R-WA) and Brian Bilbray (R-CA), among others.¶ “Algae to produce green crude can be grown on non-arable land, in salt or brackish water and using carbon dioxide and sunlight as its primary feedstocks,” Teague’s statement said.¶ “Therefore, algae has not presented the same land use concerns as other biofuels and does not have any of the ‘food versus fuel’ implications that plague some other biofuels. Green crude derived from algae can be refined into drop-in transportation fuels, such as jet, gasoline and diesel, that are entirely compatible with existing infrastructure and engines. Algae can also be used to produce ethanol and biodiesel,” it noted.¶ His bill received endorsement from the Biotechnology Industry Organisation (BIO), ABO, the Southwestern Biofuels Association, Sapphire Energy, and Algenol Biofuels, Dairy Producers of New Mexico and Farm Credit Services Southwest plus various regional business, civic and economic development organisations in his district.¶ ¶ The bill passed at the start of this year’s Algal Biomass Summit in Phoenix, Arizona, earlier this week.

## AT Counterplans

### AT Cellulosic Ethanol CP – Can’t Solve

#### Cellulosic ethanol can’t meet our energy needs

Melinda Wenner, 5/1/2009, Scientific American, “the next generation of biofuels,” <http://www.scientificamerican.com/article/the-next-generation-of-biofuels/?print=true>

Most researchers agree that it’s time to dump corn-based ethanol, but they have two opposing theories about how to proceed. Jay Keasling, a chemical engineer at the University of California, Berkeley, is one of several investigators trying to make ethanol and related fuels from plants such as switchgrass, which grows quickly and resists many pests and diseases. His biggest challenge is getting yeast and other experimental microbes to digest all of the plant, including the stalks, which are tough to break down. Another sticking point for Keasling’s method is that plants require lots of space, not to mention time, to grow: our demand for plant-based fuels could surpass our ability to produce them. That is why a second group of scientists—including J. Craig Venter, the entrepreneur and biologist whose Institute for Genomic Research in Rockville, Md., played a key role in mapping the human genome—argues for a bolder approach. These researchers believe that the best biofuels will bypass crop plants—cutting out the middleman entirely—relying instead on algae and a few microorganisms that have a plantlike knack for directly and efficiently turning sunlight into energy through photosynthesis. The scheme has yet to be proved on a large scale, however. “I haven’t seen anyone really do a fair calculation of what algae can do,” Keasling notes, “and until I see that, I’m not convinced.”

### AT “Crop-based biofuels” CP – Only Algae Solves

#### Algae is the only sustainable biofuel that can offset fossil fuels

Chisti 07 (Yusuf Chisti. School of Engineering Massey University.“Biodiesel from microalgae beats bioethanol” Science Direct. December 2, 2007)

Renewable biofuels are needed to displace petroleum-derived transport fuels, which contribute to global warming and are of limited availability. Biodiesel and bioethanol are the two potential renewable fuels that have attracted the most attention. As demonstrated here**, biodiesel and bioethanol produced from agricultural crops using existing methods cannot sustainably replace fossil-based transport fuels, but there is an alternative. Biodiesel from microalgae seems to be the only renewable biofuel that has the potential to completely displace petroleum-derived transport fuels without adversely affecting supply of food and other crop products**. Most productive oil crops, such as oil palm, do not come close to **microalgae in being able to sustainably provide the necessary amounts of biodiesel. Similarly, bioethanol from sugarcane is no match for microalgal biodiesel.**

### AT “Crop-based biofuels” CP – Food Prices Turn

#### Crop-based biofuels increase food prices and create scarcity

Justin Mullins, January 2009, “biofuel from the oceans,” <http://www.newscientist.com/article/dn16456-invention-biofuel-from-the-oceans.html#.U6YQ0o2VkSc>

Almost all commercially produced liquid biofuels come from either sugary crops like sugar beet or cane, or starchy ones like potatoes or corn. But every acre used to cultivate those crops uses one that could grow food - potentially causing food shortages and pushing up prices.¶ Using woody material instead of crops could sidestep this to some extent by using biomass from more unproductive land. And producing biofuels from freshwater algae cultivated in outdoor ponds or tanks could also use land unsuitable for agriculture. But neither approach has been made commercially available.¶ Now a group at the Korea Institute of Technology in South Korea has developed a way to use marine algae, or seaweed, to produce bioethanol and avoid taking up land altogether.

### AT “Crop-based biofuels” CP – Can’t Solve Airlines

#### Ethanol can’t fuel airlines – only algae biofuels solve that advantage

Chenda Ngak, 7/8/2013, CBS Money Watch, “powering the future: will algae fuel your next car?” <http://www.cbsnews.com/news/powering-the-future-will-algae-fuel-your-next-car/>

"We cannot fly planes with ethanol. We need oil. And algae can make oil as a drop-in replacement for fossil fuel," Polle told CBSNews.com on a recent tour of his lab.¶ Proponents find algae appealing because it can be grown in salt water. The race to find a sustainable alternative to oil has mainly focused on other types of biofuels, like corn-derived ethanol or vegetable oil, but these options compete with food crops. What makes algae ideal is that it can be grown in non-arable land. And while it burns carbon dioxide (CO2) like fossil fuels, it requires CO2 to photosynthesize, making it carbon neutral.

### AT “Crop-based biofuels” CP – Can’t Solve Warming

#### Crop-based biofuels can’t solve warming – they are worse than fossil fuels

Rebecca Nesbit, 3/20/2014, Laboratory News, “algal biofuels full bloom or dead in the water?” <http://www.labnews.co.uk/features/algal-biofuels-full-bloom-or-dead-in-the-water/>

Initial attempts to grow our way out of an energy crisis relied on so-called first generation biofuels. These are made from sugar, starch, or vegetable oil, often using traditional food crops such as corn or soya beans. Dry plant matter (lignocellulose) is the most abundant raw material in the world for the production of ethanol by fermentation, and producing bioethanol from plants is a well-established technology.¶ First generation biofuels, however, have been criticised for using crops for fuel production instead of food, which can arguably drive up food prices and cause more carbon emissions through deforestation as more land is needed to satisfy both food and energy needs. At the event, Oliver Chadwick from the Department for Transport explained that estimates of overall emissions from certain biofuels may be worse than crude oil. “To provide biofuel for one lane of cars requires a strip of land the length of that lane, and 8km wide,” he said. “Conventional biomass is just not efficient in terms of land use.”

#### Corn ethanol leads to global warming - study proves

Pollowitz 4/21

(Settled Science: Corn Ethanol Worse for Global Warming than Gasoline¶ By Greg Pollowitz¶ April 21, 2014 10:08 AM¶ Comments6¶ Print Text ¶ AP: http://www.nationalreview.com/planet-gore/376163/settled-science-corn-ethanol-worse-global-warming-gasoline-greg-pollowitz, Date Accessed: 6.22.14)//BSpencer

**Biofuels made from the leftovers of harvested corn plants are worse than gasoline for global warming** in the short term, a study shows, challenging the Obama administration’s conclusions that they are a much cleaner oil alternative and will help combat climate change.¶ **A $500,000 study paid for by the federal government and released Sunday in the peer-reviewed journal Nature Climate Change concludes that biofuels made with corn residue release 7 percent more greenhouse gases in the early years compared with conventional gasoline.**¶ While biofuels are better in the long run, the study says they won’t meet a standard set in a 2007 energy law to qualify as renewable fuel.¶ **The conclusions deal a blow to** what are known as cellulosic biofuels, which have received more than a billion dollars in federal support but have struggled to meet volume targets mandated by law. **About half of the initial market in cellulosics is expected to be derived from corn residue**.

### AT “Land Algae/Open Ponds” CP – Won’t Solve

#### Open pond methods fail – cost and contamination makes biofuel production uneconomical

Zhiyou Wen and Michael Johnson, (Biological Systems Engineers at Virginia Tech), 2009, Virginia Cooperative Extension, “microalgae as a feedstock for biofuel producation,” <http://pubs.ext.vt.edu/422/442-886/442-886_pdf.pdf>

Open ponds are the oldest and simplest systems for¶ mass cultivation of microalgae. In this system, the¶ shallow pond is usually about one-foot deep, and algae¶ are cultured under conditions identical to their natural¶ environment. The pond is designed in a raceway configuration,¶ in which a paddlewheel circulates and mixes¶ the algal cells and nutrients (figure 2). The raceways are¶ typically made from poured concrete, or they are simply¶ dug into the earth and lined with a plastic liner to¶ prevent the ground from soaking up the liquid. Baffles¶ in the channel guide the flow around the bends in order¶ to minimize space. The system is often operated in a continuous mode, i.e.,¶ the fresh feed (containing nutrients including nitrogen¶ phosphorus and inorganic salts) is added in front of the¶ paddlewheel, and algal broth is harvested behind the¶ paddlewheel after it has circulated through the loop.¶ Depending on the nutrients required by algal species,¶ several sources of wastewater—such as dairy/swine¶ lagoon effluent and municipal wastewater—can be¶ used for algal culture. For some marine-type microalgae,¶ seawater or water with high salinity can be used. Although open ponds cost less to build and operate¶ than enclosed photobioreactors, this culture system has¶ its intrinsic disadvantages. Because they are open-air¶ systems, they often experience a lot of water loss due to¶ evaporation. Thus, open ponds do not allow microalgae¶ to use carbon dioxide as efficiently, and biomass production¶ is limited (Chisti 2007). Biomass productivity¶ is also limited by contamination with unwanted algal¶ species as well as organisms that feed on algae. In addition,¶ optimal culture conditions are difficult to maintain¶ in open ponds, and recovering the biomass from such a¶ dilute culture is expensive (Molina Grima et al. 1999).

#### Bioreactors are comparatively better than the pond method

Zhiyou Wen and Michael Johnson, (Biological Systems Engineers at Virginia Tech), 2009, Virginia Cooperative Extension, “microalgae as a feedstock for biofuel producation,” <http://pubs.ext.vt.edu/422/442-886/442-886_pdf.pdf>

The advantages of enclosed photobioreactors are obvious.¶ They can overcome the problems of contamination¶ and evaporation encountered in open ponds (Molina¶ Grima et al. 1999). The biomass productivity of photobioreactors¶ can average 13 times more than that of¶ a traditional raceway pond. Harvest of biomass from¶ photobioreactors is less expensive than from raceway¶ ponds, because the typical algal biomass is about 30¶ times as concentrated as the biomass found in raceways¶ (Chisti 2007).

#### Open ponds are inefficient – OMEGA is the best option

Trent 13 (Dr. Jonathan Trent in his personal capacity as a scientist and professor)Jun 21, 2013 “NASA OMEGA Project: The Ocean as a Platform for Biofuel”

http://blog.planetos.com/nasa-omega-project-the-ocean-as-a-platform-for-biofuel/

There is no alternative, considering the constraint that biofuels must be made from wastewater and considering where the sources of wastewater are located. Look, we know how much energy we have from the sun, in different part of the world and we know the efficiency of photosynthesis; we can calculate the Kilojoules per square meter per day (kJ/m2/da) output.¶ If we are generous about photosynthetic efficiency, which is on average <1%, but we assume it can be practically pushed to 5.6%, we can get about 500 kJ/m2/da from algae. All this embedded energy would be used up if we have to pump wastewater from cities out to some remote site where there is space to grow thousands of acres of algae. In other words, we cannot pump wastewater from our cities to algae ponds and we cannot build algae ponds inside our cities without destroying the urban infrastructure.¶ We might be able to build photobioreactors in our cities, but they have to be cooled on land, which is another waste of energy. OMEGA (offshore) is the only option. Besides, we already pump our wastewater offshore, it doesn’t impact urban infrastructure, and the floating photobioreactors are cooled by seawater.

#### Evaporation and fossil fuel dependence mean open ponds can’t solve

Lozanova 14 (Sarah Lozanova journalist) “Cheaper Renewable Fuels: Is Algae the Missing Ingredient?” May 23rd, 2014 http://www.triplepundit.com/2014/05/cheaper-renewable-fuels-algae-missing-ingredient/

Algae-based biofuels have numerous pros and cons when compared to other sources of biofuels and oil products. Algae can be grown all year long and doesn’t require petroleum-based fertilizers. Algae ponds, however, can be expensive and difficult to manage, and the process requires carbon–making it dependent on fossil fuels. The viability of algae-based fuels however varies widely by the process, and some closed systems processes seem very promising. ¶ “Not all algae can be lumped together,” says Paul Woods, CEO of Algenol, a biotechnology company that produces ethanol and other fuels. “There are lots of [algae-based biofuel] programs that use fresh water and open ponds that have high evaporation rates, even if they use brines. Algenol has a closed system. Ethanol evaporates. If we had an open system, we would lose all our product and because it is closed, it isn’t subject to evaporation.”¶

#### Land-based algae production is not cost effective

NASA 14 March 10th, 2014 “Offshore Membrane Enclosures for Growing Algae (OMEGA)”http://www.nasa.gov/ames/research/space-biosciences/omega-project/#.U6c-IfldVlo

If you consider the scale of algae cultivation required to meet our current appetite for fuels and you put that in the context of the growing world population with food and water requirements, it is clear that whatever we do to make algae biofuels cannot compete with agriculture. For me this meant that we can't use freshwater and we can't use fertilizer, and in my view we can't even use land. I don't buy the argument about using the so-called non-arable land for algae cultivation, because if we made all the effort of transporting water and fertilizer to non-arable land to grow algae, why wouldn't we make it arable land and start growing food on it?¶ I suppose if we were pumping seawater to the non-arable land it would be another story, but in general pumping water is energy intensive and not cost effective. In any case, back in 2008, thinking about all the problems associated with super-large-scale algae cultivation, I had the inspiration for Offshore Membrane Enclosures for Growing Algae (OMEGA). We've been working ever since then to prove or disprove the feasibility of this offshore approach.

#### Algae ponds can’t solve – energy efficiency and infrastructure

Trent 13 (Jonathon Trent, NASA astrobiologist and founder of OMEGA, , “NASA OMEGA Project: The Ocean as a Platform for Biofuel” interview on the Planet OS blog, Jun 21, 2013)

Why did you choose the ocean as the platform for OMEGA?¶ There is no alternative, considering the constraint that biofuels must be made from wastewater and considering where the sources of wastewater are located. Look, we know how much energy we have from the sun, in different part of the world and we know the efficiency of photosynthesis; we can calculate the Kilojoules per square meter per day (kJ/m2/da) output.¶ If we are generous about photosynthetic efficiency, which is on average <1%, but we assume it can be practically pushed to 5.6%, we can get about 500 kJ/m2/da from algae. All this embedded energy would be used up if we have to pump wastewater from cities out to some remote site where there is space to grow thousands of acres of algae. In other words, we cannot pump wastewater from our cities to algae ponds and we cannot build algae ponds inside our cities without destroying the urban infrastructure.¶ We might be able to build photobioreactors in our cities, but they have to be cooled on land, which is another waste of energy. OMEGA (offshore) is the only option. Besides, we already pump our wastewater offshore, it doesn’t impact urban infrastructure, and the floating photobioreactors are cooled by seawater. This obviously only works for coastal cities, the good news is that most major cities in the world are coastal.

#### Open Ponds Creates Inefficient Algae Production

Briggs 12 (Michael Briggs, University of New Hampshire, Physics Department. “Widescale Biodiesel Production from Algae.” *Energy Independence*. September 24, 2012.)JC

**Experience with open pond algae production has shown significant problems.** Although the final stage of algae oil production—converting the lipids into biodiesel—is a proven cost effective process, **growing the microalgae** lipids **in open ponds is not so easy**. Unfortunately, the high yield, high lipid-content **algae strains are contaminated when grown in open ponds**. **The open ponds are invaded by local species, which are often low lipid-content algae strains that dominate the weaker high-lipid algae; causing lipid production to suffer.** Research is focused on genetically altering the algae, attempting to develop a dominate high-lipid strain.

#### Open Ponds get contaminated

Richmond 08 Amos Richmond Handbook of Microalgal Culture: Biotechnology and Applied Phycology Handbook of Microalgal Culture: Biotechnology and Applied Phycology. Amos Richmond is at the Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Israel

9.7 Photobioreactors versus open ponds Together with the open surface, the major drawback of open ponds is the fact that for practical reasons the water level can not be kept much lower than 15 cm (i.e. 1501m-2). Optimal standing crops for algae are generally below 100 g m-2, hence the cell concentration of the culture in a pond must be maintained at about 0.65g1-1 or below. These diluted, open algal cultures become readily contaminated by other faster-growing microalgae, bacteria and protozoa. PBR have much higher s/v ratios (typically from 20 to 200m'') than open ponds (from 5 to 10 m- ) and can sustain much higher cell concentrations. The higher population density, together with a more protected environment and a better control over growth parameters (pH, P02, pCO2 and temperature), makes closed reactors relatively safe from invasion by competing microorganisms. Comparison of performances achieved by open ponds and PM may not be easy, as the evaluation depends on several factors, among which the algal species cultivated and the method adopted to compute productivity are most important. A couple of examples may help to clarify this point. A. platensis is a well-known cyanobacterium that requires a specific and selective medium and can be grown outdoors in large-scale open ponds.

### AT “Land Algae/Open Ponds” CP – Oceans Better

#### Land-based algae production is not feasible – oceans are key to solvency

Katie Howell, 5/12/2009, Scientific American, “NASA aims for future fuel from algae-filled bags of sewage,” <http://www.scientificamerican.com/article/nasa-fuel-algae-sewage/>

But land-based methods have limits, Trent said. Open-air ponds and bioreactors gobble up large tracts of land that would be taxed and could potentially compete with agriculture. And even in deserts, where farming is less likely, evaporation of open-air ponds is a threat. Closed bioreactors face similar hurdles. They must be extremely robust in order to hold large amounts of water against air.¶ "We've solved the problem of evaporation, weeds, structure," Trent said. "And we think we've added other benefits like processing sewage and sequestering carbon."¶ Trent envisions the OMEGAs producing enough fuel to fill U.S. aviation needs – 21 billion gallons a year. Doing so would require about 10 acres of ocean, he said.¶ "It seems huge, but it's a small area in the overall oceans," he said. "And we imagine [the OMEGAs] distributed around, locally distributed ... or franchised and monitored by fishermen."

#### Only offshore algae biofuels are viable

Nico Danan and Dr. Jonathan Trent, (interview between Danan and Trent), 6/21/2013, Planet OS, “NASA OMEGA project: the ocean as a platform for biofuel,” <http://blog.planetos.com/nasa-omega-project-the-ocean-as-a-platform-for-biofuel/>

[Q:] Why did you choose the ocean as the platform for OMEGA?¶ [A:] There is no alternative, considering the constraint that biofuels must be made from wastewater and considering where the sources of wastewater are located. Look, we know how much energy we have from the sun, in different part of the world and we know the efficiency of photosynthesis; we can calculate the Kilojoules per square meter per day (kJ/m2/da) output.¶ If we are generous about photosynthetic efficiency, which is on average <1%, but we assume it can be practically pushed to 5.6%, we can get about 500 kJ/m2/da from algae. All this embedded energy would be used up if we have to pump wastewater from cities out to some remote site where there is space to grow thousands of acres of algae. In other words, we cannot pump wastewater from our cities to algae ponds and we cannot build algae ponds inside our cities without destroying the urban infrastructure.¶ We might be able to build photobioreactors in our cities, but they have to be cooled on land, which is another waste of energy. OMEGA (offshore) is the only option. Besides, we already pump our wastewater offshore, it doesn’t impact urban infrastructure, and the floating photobioreactors are cooled by seawater. This obviously only works for coastal cities, the good news is that most major cities in the world are coastal.

### AT “Land Algae/Open Ponds” CP – Bioreactors Better

#### PBRs Solve Better than Open Ponds

Lamonica 12 (Martin Lamonica. Sapphire Energy Technology Review. I’m a contributing editor at MIT Technology Review, where I write a blog on energy technology. I report on innovations in energy and write news analysis articles on how these technologies come to market. “In Race To Algae Fuel, Sapphire Scores Point For Open Ponds.” *Sapphire Energy*. September 6, 2014.)JC

**Sapphire Energy contends its choice of an open pond design, rather than closed photobioreactors,** should more or less settle the question over how to best cultivate algae for fuel production. In the low-margin fuel industry, cost is everything and the advantages of bioreactors don’t justify their added expense, says Zenk.¶ “We can grow corn in a greenhouse faster, too, but we don’t because it’s too expensive to produce a commodity that way. Algae production needs to look like an agronomic system along the lines of rice,” he says.¶ **Photobioreactors, which could be glass or plastic tubes, are a closed environment so growers should have more control over light and environmental factors to increase yield and avoid another breed of algae from taking over. There’s also less loss of water through evaporation. Open ponds, meanwhile, expose algae to diseases and predators which makes it harder to maintain growth.**

#### Closed bioreactors in the ocean are better than open open ponds- laundry list of reasons

Kodner 10 April 24, 2010 robin Kodner: I am a research scientist who has been studying algae for over 13 years. I received my PhD at Harvard, did a postdoctoral fellowship at the University of Washington, was the Director of Research for Bodega Algae and am “Open Ponds vs Closed Reactors: some science behind how to grow lots of algae“http://algaeenergy.blogspot.com/2010/04/open-ponds-vs-closed-reactors-some.html

1)Controlling growing conditions The first thing to consider when thinking about cultivating microbes on a large scale is what are you growing. There is a lot of working being done on strain selection buy a number of government labs, academic labs, and private companies. They are all trying to determine which algae will grow best, under what conditions, and which will produce the most lipids. This is because not all algae are the same physiological and biochemically - not to mention their diverse evolutionary origins (see <http://algaeenergy.blogspot.com/2010/03/what-are-algae.html> ). At "normal" culture conditions algae do not grow that densely. Since the we are algae talking about grow photosynthetically inwater, an algal culture is mostly water. A typical, run of the mill culture will yield roughly .1 g biomass/L. Now there is a huge range of growth rates in algae. Some are like weeds and will grow very fast, some are specialist and will grow really slow. The fastest growing ones, under normal condition can produce .5g biomass/L. The predictions to make growing algae as a biofuel feedstock economical is that we would have to grow at least 10 g/L but maybe even more like 50 g/L. Some people have achieved these densities in very specialized systems with small volumes on the order of 200 mL and I have heard claims that individuals or companies have achieved these densities in larger volumes recently but this is no simple task. Therefore, to produce very high density cultures in large volumes as the industry needs to, we need to do something clever. I often describe it as "factory farming" the algae. We need to engineer the algae or we need to engineer the system to be optimal growing conditions. Closed bioreactors allow for careful control of growing conditions where open ponds are subject to the weather. In the event that some group wants to grow genetically modified algae (I'll speak to this matter in another post) they would need to do this in a closed system so that the gentically modified organism was not allowed under any circumstances to be released to the environment. 2. Contamination One of the biggest problems for the long term in any cultivation of algae is contamination - but this is especially problematic when growing on a large scale. In the lab, scientist take careful measures to make sure they are always working with sterile equipment, transfer algal culture in laminar flow hoods that limit the number of air born particles that come in contact with the culture, and they transfer the culture often to make sure an individual strain stays healthy. In large scale cultivation, it is difficult to control all these factors. In a open pond, it can be almost impossible. A friend mine who works on open pond systems said their group is focused on isolating natural strains that are already known to do well under local condition against competitors. This is true, and a cleaver strategy. However, we still do not understand all the aspects of the delicate balance found in microbial communities. Thus, I think it will always be difficult to control and maintain algal growth in open ponds where the culturing system is in contact with the open air. Close bioreactors are subject to contamination issues as well, but careful design and management can greatly reduce to chance of contamination. 3. Footprint On of the benefits of using algae is their cultivation doesn't necessary require a large land footprint or arable land. Many of the open pond designs are large, shallow ponds that have a large surface area. Close bioreactors have flexibility in their design to allow for various shapes, stacking, integration with other building structures, and in general can have a much smaller footprint for the same amount of volume cultivated. In both cases, the biggest obstacle in scaling up is light limitation. In dense algal cultures, the optical path, or the distance light can travel through a material, is 3 in. That is why some many of the photobioreactor designs are thin plates, tubes, or bags. This is also why open ponds must be shallow. So photobioreactors techologies, such as Bodega Algae's reactor, work to get around this limitation by delivering light into larger volumes. If this can be done efficiently and with inexpensive materials, its possible to start cultivating much larger volumes without light limitation. For high cultivation densities, the algae need to have just the right amount of light. Too much light causes photoinhibition, where the cellular activities are shut down, and too little light means that the system is not as productive as possible. Light can be much easier to control in a closed system which optimizes the amount of biomass per unit area.

### AT “Land Algae/Open Ponds” CP – Solvency

#### Several drawbacks to open pond algae systems

Oilgae June 24, 2014 (comprehensive resource providing intelligence on a wide range of fuel and non-fuel products and solutions from algae.) “Cultivation of Algae in Open Ponds” 6/24/14 SB

http://www.oilgae.com/algae/cult/op/op.html

Cultivation of algae in open ponds has been extensively studied. Open ponds can be categorized into natural waters (lakes, lagoons, ponds) and artificial ponds or containers. The most commonly used systems include shallow big ponds, tanks, circular ponds and raceway ponds. One of the major advantages of open ponds is that they are easier to construct and operate than most closed systems. However, major limitations in open ponds include poor light utilization by the cells, evaporative losses, diffusion of CO2 to the atmosphere, and requirement of large areas of land. Furthermore, contamination by predators and other fast growing heterotrophs have restricted the commercial production of algae in open culture systems to only those organisms that can grow under extreme conditions. Also, due to inefficient stirring mechanisms in open cultivation systems, their mass transfer rates are very poor resulting to low biomass productivity.¶ ¶ The ponds in which the algae are cultivated are usually what are called the “raceway ponds”. In these ponds, the algae, water & nutrients circulate around a racetrack. With paddlewheels providing the flow, algae are kept suspended in the water, and are circulated back to the surface on a regular frequency. The ponds are usually kept shallow because the algae need to be exposed to sunlight, and sunlight can only penetrate the pond water to a limited depth. The ponds are operated in a continuous manner, with CO2 and nutrients being constantly fed to the ponds, while algae-containing water is removed at the other end.¶ The biggest advantage of these open ponds is their simplicity, resulting in low production costs and low operating costs. While this is indeed the simplest of all the growing techniques, it has some drawbacks owing to the fact that the environment in and around the pond is not completely under control. Bad weather can stunt algae growth. Contamination from strains of bacteria or other outside organisms often results in undesirable species taking over the desired algae growing in the pond. The water in which the algae grow also has to be kept at a certain temperature, which can be difficult to maintain. Another drawback is the uneven light intensity and distribution within the pond.¶ The NREL’s Aquatic Species Program (ASP) used open ponds for its experiments and has also favoured the same for the future primarily owing to its economic value. However, many companies today are trying out with Closed Pond systems and in many cases, with the much more expensive photobioreactors.

### AT “Land Algae/Open Ponds” CP – Solvency Deficit (Not Enough Water)

#### There isn’t enough water to grow algae on land

C.R.C., 9/1/2012, Capital Research Center, “algae energy - dead in the water?” <http://capitalresearch.org/2012/09/algae-energy-dead-in-the-water/>

Obama alluded to the problematic nature of algae energy himself, whether knowingly or not, when he spoke to the Miami students in February. He bragged that algal biofuel could replace 17 percent of our transportation oil use, amounting to roughly 21 billion gallons a year. Talk about aiming high: Obama and his administration are spending billions in the hopes of producing less than a quarter of our transportation oil use, which itself only makes up 70 percent of our total oil consumption, according to the Institute for Energy Research.¶ But, of course, there’s a reason for everything. Citing a study performed by the Pacific Northwest National Laboratory, Larry Bell reports in Forbes that even to replace that small percentage of our oil consumption would require algae cultivation across a land area roughly the size of South Carolina, plus about 25 percent of all U.S water currently consumed for crop irrigation, just to compensate for evaporation. Beyond that, a considerable amount of energy would be needed to provide an optimal environment for the algae—which includes tasks like maintaining temperature, preventing contamination, and providing adequate light—not to mention the energy necessary to process the fuel, another large drain on resources.¶ And all of that to make only 21 million gallons of algae biofuel. Imagine the resources needed to produce the 140 million gallons per year required to replace all petroleum-based transportation fuel.¶ The Pacific Northwest National Laboratory did the math: As Forbes columnist Jeff McMahon notes, the laboratory calculated that because it takes 350 gallons of water to produce 1 gallon of algal oil, the US would need to provide algae production three times the total water currently used for all existing agricultural irrigation, a controversial proposition in a world with limited freshwater resources. And, Barry Gutierrez adds, this algae project would use 95 million of the available 434 million acres of cropland in the contiguous United States. Dedicating nearly a quarter of our total farmland to algae would mean less home-grown food and higher food costs for the American public.

#### Land-based algae can’t solve – not enough water

Michael Hannon et al., 8/8/2011, National Institutes of Health, “biofuels from algae: challenges and potential,” <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3152439/>

Water is potentially a major limiting factor in algal growth. Expansion of algal growth into nonarable land will require water; fortunately, many of these regions have substantial alkaline or saline water reservoirs beneath them, providing a significant source of nonpotable water that is suitable for growth of many algal species. Perhaps surprisingly, algae grown in open ponds have water requirements per unit area similar to that of cotton or wheat, but less than that of corn, to replenish the water lost in evaporation (for an overview of water requirements of terrestrial plants used in biofuel production see [33]). It is imperative when considering broad deployment of algae, to consider water use to avoid a future ‘water versus fuel’ debate. Although substantial alkaline reserves are available, water will remain a central issue for algae biofuels production and will need to be considered carefully as the industry expands.

#### Land-based algae triggers water scarcity

Wall 12 <http://news.discovery.com/earth/oceans/oceanic-algae-could-produce-oil-121129.htm> “Oceanic Algae Can Be Crude, Oil That Is“ 11/29/12 Tim Wall: My diverse range of experiences includes working as a lab tech on the Human Genome Project, teaching journalism

 to 230 Honduran grade-schoolers, maintaining basil and bluegill in an aquaponics system.

Growing algal biofuels in fresh water raises several problems that salt water algae doesn’t. One, using fresh water creates another food vs. fuel debate, since crops also need fresh water. Plus, humans and livestock need to drink fresh water. All that pressure on potable water is drinking rivers dry, such as the Colorado, and is draining the world’s easily accessible aquifers faster than they are being replenished. Using oceanic algae could also open up the vast oceans as potential bio-oil production areas. [Sapphire Energy](http://www.sapphireenergy.com/), which produces algal biofuel in water-poor New Mexico, states on their website that their operations are already designed to not compete for fresh water. The company already uses salt water, albeit on dry land, and expects to produce 100 barrels per day of algal crude oil in 2013. Sapphire collaborated with UC San Diego on this research. Fossil fuel extraction and transport operations, such as coal slurry pipelines and hydraulic fracturing of methane deposits (fracking), use tremendous amounts of fresh water. Considering that one main goal of biofuels is to solve the problems created by fossil fuels, growing algae in a way that doesn’t compete for drinking water is another feather in its cap.

### AT “Land Algae/Open Ponds” CP – Solvency Deficit (Fertilizer)

#### Peak phosphorus is the Achilles heel of land-based algae – it makes production unsustainable

Tracey Schelmetic, 2/19/2013, Thomasnet News, “biofuel from algae part one: the pros and cons of pond scum,” <http://news.thomasnet.com/IMT/2013/02/19/biofuel-from-algae-part-one-the-pros-and-cons-of-pond-scum/>

The cultivation of algae (like the cultivation of most other plants) requires large amounts of phosphorus as a fertilizer, and while it’s not an oft-discussed topic, the world is currently on the brink of a peak of availability of Earth’s finite phosphate resources. “Peak phosphorus,” as it’s called, is the point in time at which the maximum global phosphorus production rate is reached. According to some researchers, Earth’s phosphorus reserves are expected to be completely depleted in 50 to 100 years, and peak phosphorus will be reached by the year 2030. (This is a fairly scary prospect for global agriculture, not just for algae production). To succeed, large scale algae production will need to reduce its use of phosphorus and find ways of reusing what it does require. The need for phosphorus in cultivation has been called by Forbes “The Achilles Heel” of algae biofuel.

### AT “Land Algae/Open Ponds” CP – Water Scarcity Turn

#### Land-based algae strains fresh water reserves in the US – that causes mass scarcity

Tim Wall, 11/29/2012, Discovery News, “oceanic agar can be crude, oil that is,” <http://news.discovery.com/earth/oceans/oceanic-algae-could-produce-oil-121129.htm>

Marine algae bio-oil rigs could keep the plant-powered power source from¶ competing for shrinking fresh water supplies, while greatly expanding¶ the area available for production.¶ “What this means is that you can use ocean water to grow the algae that will be used to produce biofuels. And once you can use ocean water, you are no longer limited by the constraints associated with fresh water. Ocean water is simply not a limited resource on this planet,” said Stephen Mayfield, a biologist at UC San Diego who led a study on the feasibility of using marine algal species to produce biofuel, in a press release.¶ Growing algal biofuels in fresh water raises several problems that salt water algae doesn’t. One, using fresh water creates another food vs. fuel debate, since crops also need fresh water. Plus, humans and livestock need to drink fresh water. All that pressure on potable water is drinking rivers dry, such as the Colorado, and is draining the world’s easily accessible aquifers faster than they are being replenished. Using oceanic algae could also open up the vast oceans as potential bio-oil production areas.

#### Water systems are already stressed in the US – additional pressures will devastate agricultural production

Grace Wyler, 5/22/2013, Business Insider, “all around the US, risks of a water crisis are much bigger than people realize,” <http://www.businessinsider.com/us-drought-water-scarcity-2013-5>

With about half of the country still suffering from extreme drought, farmers and businesses in the Western United States are looking at another hot, dry summer. ¶ And the country's water risk is a lot worse than most assessments suggest, according to a recent study from the Columbia University Water Center. ¶ Taking into account past patterns of drought and water use, the Columbia study reveals that several major metro areas, including New York City, Washington, D.C., and Los Angeles, are at high risk for water scarcity, along with the Great Plains agricultural belt extending from North and South Dakota down to North Texas. ¶ Here's a list of the top 10 areas with the highest risk for water scarcity: ¶ Washington DC metro area¶ New York metro area¶ California area, from San Diego to Santa Barbara and inland¶ Agricultural belt: Dakotas¶ Agricultural belt: Nebraska¶ Illinois¶ Lower Mississippi belt: Arkansas area¶ Agricultural belt: North Texas¶ Agricultural regions in Ohio¶ Agricultural regions in Minnesota¶ "All cities and all businesses require water, yet in many regions, they need more water than is actually available — and that demand is growing," said Upmanu Lall, director, Columbia Water Center. "The new study reveals that certain areas face exposure to drought, which will magnify existing problems of water supply and demand." ¶ The study notes that a 99% population increase since 1950 combined with a 127% increase in water use has further decreased water availability, making it increasingly difficult to replenish water supplies after a drought. ¶ The report doesn't predict when or where the water scarcity will become an issue. In New York and Washington, D.C., for example, water is brought in from outside of the city from other sources, which are typically plentiful. ¶ In other areas, however, the current drought — the worst since the Great Depression — is already bringing water availability issues to the fore. ¶ According to the most recent federal forecast, about 48% of the contiguous U.S. is now experiencing moderate to exceptional drought, down from a high of 60% at the beginning of the year. The drought is expected to intensify in the West this summer, and while conditions should "ease" in the Plains states, the drought is not expected to end anytime soon and temperatures are expected to be above-normal for most of the lower 48 this summer. ¶ "Even if you don't believe in climate change, the North American continent historically has had frequent and severe droughts," Lall said. "There are very significant droughts that have happened here historically — they are not that unusual." ¶ The New York Times highlighted the growing water worries this week, with a story examining the depleting resources of the High Plains Aquifer, which provides irrigation for agricultural centers in the Midwest. ¶ The Times reports: ¶ Two years of extreme drought, during which farmers relied almost completely on groundwater, have brought the seriousness of the problem home. In 2011 and 2012, the Kansas Geological Survey reports, the average water level in the state’s portion of the aquifer dropped 4.25 feet — nearly a third of the total decline since 1996.¶ As the Atlantic Wire's Philip Bump points out, the High Plains Aquifer has been a "hydrological savings account" for farmers in the Great Plains. But as the aquifer's resources dwindle, farmers are being forced to subsist on water from rainfall, at the same time that rainstorms are becoming less and less frequent. ¶ The ramifications for agriculture and business are predictably devastating.

#### Collapse of American agriculture triggers famine and kills billions

Jon Wefald, President, Kansas State University, "US Senator Pat Roberts (R-KS) Holds Hearing on Terrorism," Emerging Threats Committee of the Senate Armed Services, October 27, 1999. Lexis.

Well, what I'd like to do first is to talk about how it might impact on American agriculture. And to begin with, I think we all have to understand that American agriculture is the greatest industry in America today. Quite frankly, without American agriculture, we would not have our soaring, booming company of the 1990s as we get ready to enter the 21st century. When you stop to consider that American agriculture produces more corn and soybeans than any country in the world or any set of countries, that America produces unlimited quantities of the safest, highest-quality food and fiber of any country on the face of the earth, we feed the American people better than any other people in the world, and 30 percent of the world's population are fed by our enormous productive, efficient food and fiber system. When you stop to consider that agriculture represents about 15 percent of our gross national product, that it's a $1 trillion industry, that it represents at least 22 million jobs, and that it is so important to America and our economy, agriculture is a fundamental engine of American prosperity as we are poised to enter the 21st century.

### AT “Land Algae/Open Ponds” CP – Perm Solvency

#### Perm Do Both- PBR and Open Ponds Solve Together

Lamonica 12 (Martin Lamonica. Sapphire Energy Technology Review. I’m a contributing editor at MIT Technology Review, where I write a blog on energy technology. I report on innovations in energy and write news analysis articles on how these technologies come to market. “In Race To Algae Fuel, Sapphire Scores Point For Open Ponds.” *Sapphire Energy*. September 6, 2014.)JC

**Using bioreactors in conjunction with open pond farms is a viable option**, too, **according to a 2010 study from the National Renewable Energy Laboratories. Hawaii-based Cellana**, for example, **cultivates new cultures in photobioreactors and then transfers the alge to marine open ponds.**¶ **Apart from producing algae biomass, there are significant challenges in harvesting the biomass and extracting oil and water.** The cost of all these steps needs to be reduced in order to compete with the price of oil.¶ When oil prices were climbing near $140 a barrel four years ago, a number of algae startups and research efforts formed. But since then, some companies have gone out of business and it's still not clear that algae-based fuel can be cost competitive with petroleum**.**¶ **Sapphire Energy projects that once its open-pond process is done at larger plant and it implements other cost-saving techniques, it can match oil at $85 a barrel. As Sapphire and companies with alternative designs seek to scale up, we'll see whether algae can be made cheaper than oil.**

### AT “Land Algae/Open Ponds” CP – Land Use

#### Open Ponds need too much land

Biomass 10 April 2010 Biomass magazine is a monthly trade publication tailored to serve companies and organizations engaged in producing or utilizing biomass power and heat, advanced biofuels, biogas, wood pellets and biobased chemicals. “Open Ponds versus Closed Bioreactors”

http://biomassmagazine.com/articles/3618/open-ponds-versus-closed--bioreactors/

Dahmen describes open ponds as a "first-generation solution" to growing algae. "They're very land intensive because the effective cultivation area is limited to a very thin slice of growth medium, so the ponds have to expand, becoming very land hungry," he says. "Also, if you look at the areas receiving high amounts of natural sunlight or insolation where ponds make the most sense, you run into tremendous problems with evaporation as well as cross-contamination of cultures. When you start talking about acres and acres of ponds 16 inches deep, you've increased the surface area to the point where land consumption is a huge problem."

### AT Military CP – First Mover Bad

#### The military should not be the first mover for biofuels – that constraints the DOD budget which hurts national security and military readiness

Gay 14

(John E. Gay, April 01, 2014, National Defense University Press, “JFQ 73 | Green Peace: Can Biofuels Accelerate Energy Security?”, http://ndupress.ndu.edu/Media/News/NewsArticleView/tabid/7849/Article/8465/jfq-73-green-peace-can-biofuels-accelerate-energy-security.aspx)

For the United States to achieve energy security, it must reduce its dependence on foreign oil. However, should the military—the branch of government responsible for national security—be responsible for investing its limited resources as a venture capitalist to jumpstart a biofuels industry and be forced to purchase fuels at 10 times the cost of readily available petroleum-based fuels? Not only does this not make good economic sense, but it also puts our national security at risk. Biofuels mandates divert scarce military resources away from critical programs such as weapons modernization, maintenance, training, and readiness. America’s military is the largest consumer of liquid fuels in the world, but it still only accounts for 3.6 percent of annual U.S. consumption. This low percentage is not enough to spark a biofuels industry and affect overall fuel prices.

### AT Military CP – Solvency (NDAA Prevents)

#### NDAA prevents DoD purchase of drop-in fuels like algae biofuels-destroys solvency

Medici 14

(ANDY MEDICI, Jan. 3, 2014, Federal Times, “NDAA could hamper DoD biofuel efforts”, http://www.federaltimes.com/article/20140103/ACQ02/301030008/NDAA-could-hamper-DoD-biofuel-efforts)

The National Defense Authorization Act of 2014 signed by President Obama Dec. 26 would hamper the ability of the Defense Department to purchase biofuels. The legislation bars the Defense Department from purchasing any bulk purchases of “drop-in fuel” -- defined as a replacement for traditional fuel -- until the price per gallon is equal to or less than the price of conventional fuels. An earlier version of the legislation specifically defined the drop-in fuel as anything plant-based. If the Defense Department decided to purchase the fuel it would need to issue a waiver detailing the cost of the fuel and submit it to Congress. The Navy has come under fire for its purchases of bio-fuels at above market rates to help test its use for Navy ships and aircraft.

### AT Military CP – Solvency: Procurement Fails

#### Military procurement fails to cut costs – private industry has a perverse incentive to keep costs high

Ashton Carter and John White, 2001, Keeping the Edge: Managing Defense for the Future. (p. 152-153), Google Books

Commercialization and globalization are ineluctable: DOD cannot escape or “manage” them through command-and-control regulation of industry. Powerful market and technological forces drive these changes. Resistance is futile; instead, DOD can achieve many of the nation’s goals for the offset strategy by aligning its own procurement practices with the forces at work in the global economy as a whole. Where a regulatory approach would ultimately result in a weak and isolated defense industry, propped up by the government, that falls short of prevailing standards of innovation and efficiency, a market approach will give DOD the ability to ride the tide of the dynamic global world industrial economy. Reward the Defense Industry When it Follows Sound Business Practices in Pursuit of Innovation and Efficiency. Too often the incentives given to private industry by the government are adverse to the government’s interests. DOD should share with industry the savings from cost-cutting, facility closings, and other efficiencies. On most current defense contracts, higher costs lead to higher profits, giving industry an incentive not to cut costs. If the government does not ensure the returns on investment, industry managers will not invest in new factory equipment or make other cost-cutting investments. DOD should take steps to reverse this perverse incentive. DOD should allow higher profits when industry performs successfully in terms of cost, schedule, and performance. Under current procurement rules, poorly performing companies too often enjoy the same profits as those that deliver superior value.

#### DOD procurement is a terrible financing strategy

Baker Spring, 3/2/2006, The Heritage Foundation, “a defense budget strategy for winning the long war,” <http://www.heritage.org/research/reports/2006/03/a-defense-budget-strategy-for-winning-the-long-war>

The same imbalance will drive both DOD acqui­sition authorities and defense contractors to adopt an approach that is just as counterproductive as adopting unrealistically low cost projections at the outset of a program in order to make up the differ­ence in procurement. This approach is to search for technological silver bullets, which provides an incentive to research programs to death. One such example is the Space-Based Infrared-High early warning satellite, which seems stuck in the devel­opment phase and has repeatedly generated cost overruns.[13]¶ As research and development becomes an inde­pendent profit center for defense contractors, a dif­ferent perverse incentive emerges. Put crassly, the military and acquisition executives use the require­ments process to set performance requirements at the outer reaches of what is possible. The contrac­tor responds by "promising the moon." The con­tractor profits by performing the research and development and has little incentive to push the system into the field. The program may be canceled in the end, but the contractor earns a nice profit. In the end, the military and the taxpayers get the ben­efit of some neat research but no fielded military capability.

### AT Military CP – Links to Politics

#### Military procurement links to politics

Cardwell 12 (Diane of the New York Times, “Military Spending on Biofuels Draws Fire” 8/28/12 http://www.nytimes.com/2012/08/28/business/military-spending-on-biofuels-draws-fire.html?pagewanted=all&\_r=0)//EAZYE

When the Navy put a Pacific fleet through maneuvers on a $12 million cocktail of biofuels this summer, it proved that warships could actually operate on diesel from algae or chicken fat. “It works in the engines that we have, it works in the aircraft that we have, it works in the ships that we have,” said Ray Mabus, secretary of the Navy. “It is seamless.” The still-experimental fuels are also expensive — about $27 a gallon for the fuel used in the demonstration, compared with about $3.50 a gallon for conventional military fuels. And that has made them a flash point in a larger political battle over government financing for new energy technologies. “You’re not the secretary of energy,” Representative Randy Forbes, a Republican from Virginia, told Mr. Mabus as he criticized the biofuels program at a hearing in February. “You’re the secretary of the Navy.” The House, controlled by Republicans, has already approved measures that would all but kill Pentagon spending on purchasing or investing in biofuels. A committee in the Senate, led by Democrats, has voted to save the program. The fight will heat up again when Congress takes up the Defense Department’s budget again in the fall.

#### Even if Congress generally supports the military, backlash is growing against attempts to “green the military”

Jim Michaels, 5/6/2013, USA Today, “could a greener military prove more powerful?” <http://www.usatoday.com/story/money/business/2013/05/05/green-military-power-fuel-oil-afghanistan/2132459/>

Lawmakers are mostly supportive of efforts to reduce the military's dependence on fuel, but some critics in Congress say the Navy's more ambitious plan to transition to biofuels has gone beyond those limited military objectives and is a thinly disguised environmental initiative.¶ "It's the secretary of the Navy's green agenda," says Rep. Randy Forbes, a Virginia Republican. Forbes said the expenditures on biofuels has meant less money for shipbuilding and operation and maintenance of the Navy's fleet. "He never stopped to say, 'What's the price tag?' " Forbes said of Mabus. A centerpiece of Mabus' initiative was the Great Green Fleet, a demonstration last year of the Navy's ability to operate its ships and aircraft on biofuels.¶ During the demonstration, the Navy powered a carrier strike group, which consists of escort ships and aircraft, with 50% biofuels over a two-day exercise. The biofuels were made from a number of sources, including used cooking oil and algae.¶ The Green Fleet name is a reference to President Theodore Roosevelt's Great White Fleet, a battle group that circled the globe in a demonstration of American seapower in the early part of last century.¶ Critics saw the Great Green Fleet as a demonstration of wasted taxpayer money. Sen. James Inhofe, R-Okla., has pointed out that the Navy spent $12 million for biofuels at $27 a gallon for the demonstration. The Navy acknowledges it has paid a premium for biofuels, but insists it is for experimental and test purposes only until the price becomes competitive with conventional fuel.¶ The Navy's use of the Defense Production Act, designed to allow the military to support industries considered critical to national security, to invest in biofuel refineries has drawn criticism.

#### CP links to politics - military biofuels are unpopular with dems and gop

Cardwell 12

(DIANE CARDWELL, August 27, 2012, The New York Times, “Military Spending on Biofuels Draws Fire”, http://www.nytimes.com/2012/08/28/business/military-spending-on-biofuels-draws-fire.html?pagewanted=all&\_r=0)

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But with the Defense Department facing $259 billion in budget cuts over the next five years, some lawmakers argue that the military should not be spending millions on developing new fuel markets when it is buying less equipment and considering cutting salaries. This phase of the military’s exploration of alternative fuels began under President George W. Bush and grew out of a task force that Donald Rumsfeld, then the secretary of defense, convened in 2006 to explore ways to reduce dependence on petroleum. If the military had less need to transport and protect fuel coming from the Middle East, the thinking went, the fighting forces could become more flexible and efficient, with fewer lives put at risk. In addition to biofuels, early efforts included developing liquid fuels from coal and natural gas for the Air Force, the largest energy user of the armed services. But the gas and coal fuels would not meet cost or environmental requirements, officials said. The Defense Department focused on advanced biofuels, which are generally made from plant and animal feedstocks that don’t compete with food uses, which is a concern with common renewable fuels like the corn-based ethanol used in cars. The federal Renewable Fuel Standard, which sets targets for renewable fuel production and requires a certain amount to be blended into conventional gasoline and diesel, has been the main catalyst for the growth of several companies exploring new technologies. Investors, however, have been leery of the enormous amounts of cash it can take to bring the fuels from the lab to the gas tank. Industry officials say that having a large, steady customer like the military could attract other investors to help finance large refineries that would bring costs down through economies of scale. Military officials say that their purchases of small amounts for testing has already helped reduce the cost. In 2009, the Pentagon spent roughly $424 a gallon on algae oil from Solazyme. “Finding a user like the military can rapidly help to scale technologies that then are used in the civilian marketplace — it becomes a catalyst,” said Bob Johnsen, chief executive of Primus Green Energy, which is developing fuels from biomass and natural gas. “If the military becomes a buyer, that becomes a means by which the production facilities can be financed.” The Defense Department is always vulnerable to charges of overspending — remember the $7,600 coffee maker? — but military leaders argue that what they are putting into biofuels is a blip given the potential benefits of reducing their need for Middle Eastern oil, with all its volatilities. “Our primary rationale is not economic,” said Sharon E. Burke, assistant secretary of defense for operational energy plans and programs. “Our job is to defend the country.” She said biofuel spending was just 7 percent of the $1.6 billion budget the military was requesting for efforts to improve energy usage in field operations in the next fiscal year. Most of the measures are aimed at reducing the need for fuel in the first place, including using diesel electricity generators more efficiently, putting greener engines into vehicles and aircraft, and using hybrid solar generators and batteries in the field. The Defense Department is also running several demonstration projects on its bases, testing ways to produce and distribute electricity better. And the Army recently put out a request for proposals for $7 billion in renewable energy projects, part of reaching its goal of getting a gigawatt of its electricity — enough to power roughly 250,000 American homes — from renewable sources by 2025. In Congress, there is little apparent opposition to the overall military push toward renewable power generation or energy efficiency. But the biofuel program has struck a nerve among Republicans who, ever since the government’s failed investment in the solar panel maker Solyndra, have been wasting few opportunities to hammer their message that the government should not risk taxpayer money to bolster favored technologies. Representative Mike Conaway, a Texas Republican who introduced House legislation that would limit biofuel purchasing and production and has been critical of the Great Green Fleet, said Democrats were using the military to pursue an environmental agenda. “We just want to require the Department of Defense to do exactly what every other American does when they buy fuel: they try to get the best price they can,” he said. Many of the lawmakers objecting to the biofuels program — including some Democrats who crossed the aisle to support new limits — represent coal country or take money from those in the coal and natural gas industries. Mr. Conaway, who introduced a measure that would open the door for the military to pursue alternative fuels made from coal and natural gas, gets a large share of his campaign contributions from oil and gas interests, according to OpenSecrets.org.

### AT Military CP – No Spillover

#### Military procurement prevents a spillover to the civilian sector – that also means the CP doesn’t solve international modeling

Sarah Light, December 2013, (Assistant Professor of Legal Studies and Business Ethics), The Wharton School, University of Pennsylvania, “The military-environmental complex,” <http://ppi.wpengine.netdna-cdn.com/wp-content/uploads/2012/11/issue-brief_V1_N12.pdf>

Finally, some historical examples from the military-industrial complex in the 20th century suggest that a “dual use” strategy – promoting the interests of both the military and society simultaneously – raise concerns when the military is setting technological specifications. It may reduce the potential for civilian “spillover” if technologies are built more closely to military specifications, rather than to those that would benefit society as a whole. It also raises the risk that the military will, in order to obtain a comparative advantage internationally, want to hold promising technologies close to the vest, rather than to promote technology diffusion.

## AT Topicality

### AT Oceans (Must be Salt Water)

#### OMEGA farms will be placed in salt water areas

Trent et al 2010

OFFSHORE MEMBRANE ENCLOSURES FOR GROWING ALGAE (OMEGA): ¶ A SYSTEM FOR BIOFUEL PRODUCTION, WASTEWATER TREATMENT, AND ¶ CO2 SEQUESTRATION Jonathan Trent1\*¶ , Tsegereda Embaye2¶ , Patrick Buckwalter3¶ , Tra-My Richardson3¶ , Hiromi Kagawa2¶ , Sigrid ¶ Reinsch1¶ , and Mary Martis4 <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100039342.pdf>

It is proposed that OMEGA farms will be located in ¶ marine (salty) environment in the vicinity of a source of ¶ nutrient-rich freshwater and a source of CO2, such as a ¶ coastal power plant. Other conditions, including ¶ temperatures, light, water clarity, frequency and severity ¶ of storms, geography, boat traffic, wildlife conservation, ¶ will all influence how the OMEGA farm will be configured ¶ and what algae will be cultivated. The plan is to only ¶ cultivate freshwater algae and to use wastewater that ¶ meets regulations for release into the marine ¶ environment. ¶ ¶ To accommodate sea birds and marine mammals, the ¶ OMEGA modules in a farm will be spaced to allow ample ¶ access. This also allows light to penetrate into the water ¶ column between the modules. The number of OMEGA ¶ modules in a farm will depend on the location, shipping ¶ lanes and the amount of wastewater to be processed in a ¶ given location. ¶ ¶ Obviously, OMEGA farms will be easier to build in ¶ protected bays, in areas surrounded by breakwaters, or in ¶ places with existing marine infrastructure such as ¶ offshore platforms or wind farms.